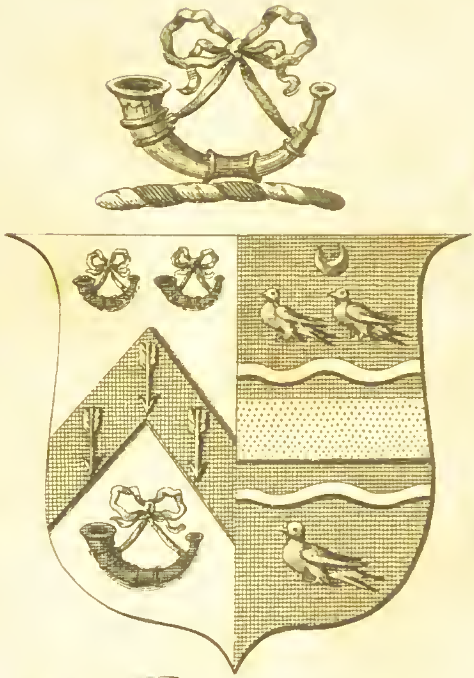

William Roots.

Wm Roots.

AN

INTRODUCTION

TO

ELECTRICITY

AND

GALVANISM;

WITH CASES, SHEWING THEIR EFFECTS IN THE CURE OF DISEASES:

To which is added, a Description of

Mr. *Cuthbertson's* PLATE ELECTRICAL MACHINE.

BY J. C. CARPUE, SURGEON.

Being the Substance of Lectures delivered to his Anatomical Class.

LONDON:

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ADVERTISEMENT.

THE following summary of Electricity and Galvanism is intended for the use of those whose avocations will not permit them to read works of more consequence.

It is rather extraordinary, that the study of Electricity should be neglected by medical students, when the application of it in disease is recommended by CULLEN, and a variety of writers on medicine and surgery of the highest reputation.

In the lecture on Electricity I have followed the theory of FRANKLIN.

The Cases are mere extracts from a journal I have kept for some years, of my own patients. On Animal Electricity or Galvanism, I have selected the most important discoveries, and omitted the theory of VOLTA, as it is not supported by experiment; nor have I seen any theory that appears conclusive.

Leicester Square,
May 30th.

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A
LECTURE
ON
ELECTRICITY.

GENTLEMEN,

PERSUADED from experience that a knowledge of the power of the Electric Fluid will be of consequence to you in your future practice, I shall do myself the honour to give you a short History and a Summary of the Science of Electricity, which I shall illustrate by experiments.—I shall read a number of cases, as well those in which I have been unsuccessful, as those wherein I have succeeded; I shall shew you the various methods of electrifying for disease, and think you will find electricity a pleasant part of your profession, as you, in many instances, will be enabled to relieve your fellow creatures from the most excruciating pains. Electricity, administered in proper cases, never can do harm: it

it should be the province of professional men to apply it.

From the Greek word electron, *i. e.* amber, is derived the term electricity.—Amber was the first substance that was known to have the power of attracting light bodies: this was known to the ancients. Thales of Miletus (600 years before Christ) imagined it was animated. Theophrastus, who lived 300 years after Thales, says in his book on precious stones, that amber has the same property of attracting light bodies as the lyncurium *: he says, it attracts not only straws, &c. &c. but thin pieces of copper and iron. Pliny, lib. 7. cap. 11. mentions the attractive power of amber.

Little advances were made in electricity till the year 1600, when Dr. Wm. Gilbert published a Latin treatise *De Magnete*, in which he relates a number of electrical experiments. He discovered, that *glass*, the *diamond*, *sealing-wax*, &c. &c. when rubbed, have the property of attracting light bodies.

Mr. Boyle increased the catalogue of electrics, and saw electric light on a diamond when rubbed. Otto Guericke, of Magdeburg (inventor of

* Dr. Watson says, the lyncurium and the tourmalin are the same substance.

of the air-pump) made an electric machine. He melted sulphur in a glass globe, broke the glass, and mounted this globe of sulphur upon an axis : he turned it in a wooden frame, rubbing it at the same time with his hand, and by this means, collected a quantity of electric fluid. He discovered, that a body once attracted *by an excited electric,* was repelled by it, and not attracted again, till it had been touched by some other body. He heard the sound, and saw the light produced by his excited globe ; he also discovered, that bodies immerged in electric atmospheres, are themselves electrified, with an electricity opposite to that of the atmosphere. The members of the academy Del Cimento, made many experiments in electricity ; they observed a visible electric atmosphere.

Sir Isaac Newton observed, that excited glass attracted light bodies on the side opposite to that on which it was rubbed.—Mr. Hawksbee, 1709, observed the great electric power of glass, and light proceeding from it, the noise occasioned by it, and a variety of phenomena, relating to electric attraction and repulsion.

Few electrical experiments seem to have been made from the time of Mr. Hawksbee till the year 1733, when Mr. Stephen Gray made the distinction between CONDUCTORS and NON-CON-

DUCTORS. Mr. Gray says, he found red, orange, and yellow, attract at least three or four times stronger than green, blue, or purple. He made an immense number of electrical experiments, which were followed up by Monsieur Du Fay, member of the Academy of Sciences at Paris. He says, that all bodies, except metallic, soft, and fluid, might be made electric, by heating them more or less, and then rubbing them on any soft cloth. He mentions the powerful electricity of the back of a dog, and that of a cat. He refutes Mr. Gray's assertion on the different electricity of colours, and says it proceeds not from the colour as a colour, but from the substance employed in dying it. He made experiments on bodies illuminated with the different primitive colours, and found the difference of colour did not make any alteration in the communication, or in destroying electricity. Mr. Du Fay, with the Abbé Nollét, first observed *the electric spark drawn from a living body,* when insulated. He demonstrated two kinds of electricity, one of which he called vitreous, the other resinous.

A number of experiments were now made in most parts of Europe. Mr. Boze, professor of philosophy at Wittenburg, substituted the glass globe for the tube, which had been used

since

since the time of Hawksbee, and added *a prime conductor*. Mr. Winckle, professor of languages at Leipsic, substituted a cushion instead of the hand, which had been before employed to excite the globe. Mr. P. Gordon, a Scotch Benedictine Monk, professor of philosophy at Erfurt, was the first that used *a cylinder instead of* a globe: his cylinder was eight inches long and four in diameter.

Electric machines were much improved by the Germans, and some curious experiments were made. In 1764 Dr. Ingenhouse invented electrical machines made of glass plates; these were first made by Mr. Ramsden, and then by many other mathematical instrument-makers, but not being judiciously constructed, their excitation was not superior, or indeed so good, as those in use. In the year 1768, Mr. Cuthbertson (of Poland Street) went to reside at Amsterdam, where he made these machines, and had great encouragement; indeed they were found to excite much better than the cylinder, and not so much affected by the damp: they were soon in general use on the Continent. In 1784 he made the famous machine at Haerlem—I have two of those machines, one of which has been, upon an average, in use four hours every day, for these six years past; and I have never been disappointed

pointed in the electric fluid: the cylinder frequently failed.

Professor Kruger discovered, that the red leaves of wild poppies, exposed to the electric effluvia, were changed to white. He was not able to produce any change in yellow colours, nor in blue immediately; but he found, that when they had laid a day or two they became white. Dr. Watson improved upon the discoveries of the Germans; his first letter to the Royal Society on this subject, was dated some time in the year 1745. The Germans had fired *the ethereal spirit* of Frobenius and rectified spirit of wine; Dr. W. fired inflammable air and gunpowder.

The end of the year 1745, and the beginning of 1746, were famous for the discovery of the accumulation of electricity on glass, called the *Leyden Phial*, so called, because the experiment was made by Mr. Cuneus, a native of Leyden; but the person who made the discovery was Mr. Von Kleest, dean of Cammin. On the 4th of November, 1745, the first shock was felt by this gentleman. He says, when a nail or piece of thick brass wire is put into an apothecary's small phial, and electrified, remarkable effects follow. Mr. Muschenbroek tried the experiment with a very thin glass bowl, and

says,

says, in a letter to Mr. Reaumur, that he felt himself struck in his arms, shoulder, and breast, so that he lost his breath, and was two days before he recovered from the effects of the blow and terror, and that he would not take a second shock for the kingdom of France. Various accounts are given of the effects of the shock: the most remarkable is that of Mr. Winckle of Leipsic. He says, that the first time he tried the Leyden experiment, he found great convulsions in his body from it, that it put his blood into such great agitation, that he was afraid of an ardent fever, and was obliged to use refrigerating medicines; he felt a heaviness in his head as if a stone lay upon it; twice it gave him a bleeding at his nose. His wife had the courage to take two shocks, and found herself so weak that she could hardly walk. A week after she received another shock, when she bled at the nose.

Mr. Gralath made the shock much stronger, by using a glass vessel five inches in diameter, with a narrow neck ten inches long, and by substituting an iron wire with a nob of tin for the iron nail, and water for spirit of wine. He made the first electrical battery. He observed, that if a phial had the least crack in it, it could not give a shock: he first found that the same shock could be communicated to a number of persons,

if a circuit was formed by holding hands, and the person at one extremity of the line they made touched the outside of the phial, and he at the other touched a wire communicating with the inside.

Dr. Bevis discovered, that the electric explosion was as great from a *pane of glass covered* with leaf silver to within an inch of the edge, as from a half pint phial of water. A number of experiments were made with the Leyden phial.

Dr. Watson, in the year 1748, at Shooter's Hill, made an electric circuit of two miles. By several turnings of the wire in the same field, he contrived that the middle of this circuit should be in the same room with the machine, where an observer took in each hand one of the extremities of the wires, each of which was a mile in length. The phial was discharged several times. The observer always felt himself shocked at the very instant of the explosion. Dr. Watson discovered, that the glass tubes and globe did not contain the electric power in themselves, but only served as first *movers*, and determiners of that power. Dr. W. and Dr. Franklin explained the discovery of Monsieur Du Fay, of the two electricities, called by him vitreous and resinous (that is, positive and negative) electricity. Dr. Franklin calls these states *plus* and *minus*. Dr. Miles observed,

served, in a paper read at the Royal Society, January 25th, 1746, that the luminous effluvia proceeded in a much greater quantity from the top of his finger to a stick of sealing-wax than it did to glass, and that a similar spot of fire appeared on his finger, from which issued regular streams towards the wax, in the form of a comet's tail. A number of curious experiments were made by the Abbé Nolet: he observed a remarkable difference between the appearance *of the electric light in vacuo* and in the open air. In the year 1741, Mr. Ellicott proposed to *estimate the strength* of *electrification*, by its power to raise a weight in one scale of a balance, while the other was held over the electrified body, and pulled to it by its attractive power. The Abbé Nolet found that the evaporation of fluids was augmented by electricity. He made experiments on the observation of Mr. Boze, that water would issue in a constant stream when it was electrified, whereas it would only drop slowly without that operation. He electrified a variety of animals, and found some of them lighter after electrification. A cat, electrified for six hours, was lighter by sixty or seventy grains; from which he concluded, that electricity increased the insensible perspiration of animals. Dr. Franklin made many discoveries: he, as well as Dr

Watson, discovered, that the electric matter was not created, but collected by friction. He observed, that in charging coated glass, whatever quantity of fluid is thrown on one side of the glass, the same is thrown out of the other, and that there is no more electric fire in the phial after it is charged than before, and that glass is impervious to electricity. Dr. F. discovered, that several substances which would conduct electricity in general, would not conduct the shock of a charged phial. A wet packthread, though it transmitted electricity, sometimes failed to conduct a shock, as did also a cake of ice.

The analogy between electricity and lightning had not been wholly unobserved, but Dr. Franklin first proposed a method of verifying this hypothesis. He made use of a discovery of Mr. Thomas Hopkinson, that points have the power to draw off the electric fluid. The first experiment on Dr. F's plan was made by Monsieur Dalibard, in 1752, at Marley, near Paris. Mons. D.'s machine consisted of an iron rod, forty feet long, the lower extremity of which was brought into a centry-box : on the outside, it was fastened to three wooden posts, by long silken strings. On Wednesday, 10th of May, 1752, between two and three o'clock in the afternoon, a person of the name of Coissier, employed by Mr. D., hearing a loud

loud clap of thunder, ran to the machine, taking with him a Leyden phial; he presented the wire in the phial to the end of the rod, and a small spark issued from it.

This was the first spark of electric fluid ever drawn from the heavens by human being. About a month after this, Dr. F., in America, demonstrated in the completest manner, the sameness of the electric fluid with the matter of lightning, by means of a kite. He raised a kite when a thunder storm was perceived to be coming on: a pointed wire was fixed upon it; this was connected to a wet hempen string; a key was tied to the extremity: that part of the string held in the hand was of silk: thus the electric fluid was stopped when it came to the key.

The Doctor made a number of experiments with this electric kite. He found that clouds were sometimes electrified positively, sometimes negatively: he constructed conductors to secure buildings from damage by lightning: he proved by experiment, that in discharging the Leyden phial, the quantity of electric fluid taken from one side, was exactly equal to that which was received by the other. The Doctor's theory of electricity, with some few exceptions, is still the most approved.

In 1751, Mr. Canton discovered, that by

 rubbing

rubbing the cushion of the electric machine with a small quantity of the amalgam of mercury, tin, and chalk, he excited the globe to a great degree.

Signor Volta discovered the electrophorus, see p. 44. Mr. Lane invented the discharging electrometer—Volta, the gold leaf electrometer—Mr. Cavallo, the multiplier of electricity—and Mr. Bennet, the condenser. See *Nicholson's Journal*, vol. i. 4to. For a more full account of the history of electricity, see Priestley's History of Electricity.

Of

Of the ELECTRIC FLUID.

There is a natural agent or power residing in all bodies, called the electric fluid: every substance has its natural quantity, and while this continues undisturbed, it is imperceptible. If it is disturbed by any cause in the earth or atmosphere, it becomes perceptible.

Of Excitation.

I rub this piece of amber: you see it has the property of attracting light bodies. I rub this glass rod: you see it attracts these pith-balls. You will shortly see, that these bodies, when rubbed, exhibit an appearance of light, áttended with a snapping noise; that a phosphoric smell is produced, as also a subacid taste. In truth, we have now disturbed the equilibrium; we have robbed some bodies of their natural quantity of electric fluid, and given to other bodies more than their natural quantity. The amber and glass are now said to be excited.—*All substances are divided by electricians into two classes, Electrics and Non-Electrics.*

Of Electrics.

Amber, glass, sealing-wax, &c. &c. are called electrics, because by friction, the electric fluid

fluid is brought into action, and rendered perceptible upon their surface.

I rub this glass, and you see it attracts light bodies, and in the dark, the electric fluid may be seen upon its surface, if a conductor be applied to it.

Of Non-Electrics.

All metals, wood, water, &c. &c. are called Non-Electrics, because, though the electric fluid is brought into action by friction, yet it is not rendered visible, nor sensible; being conducted away by the body itself, as fast as it is excited into action. I rub this brass rod, and you see it does not attract light bodies, nor is the electric fluid visible upon its surface.

Of Non-Conductors.

Electrics will not conduct the electric fluid. I will collect a quantity of electric fluid on the prime conductor (plate I. fig. 3.) of this machine. I hold my finger to it; it receives a spark. I collect more fluid on the conductor. I apply this glass rod; it will not receive a spark. I now apply a glass rod to the prime conductor, and connect it with the ground: I turn the machine. Although the glass rod is connected with the conductor and the ground, I can receive sparks: thus you see electrics are non-conductors.

Of

Of Conductors.

Conductors will conduct the electric fluid. I collect a quantity of electricity on the prime conductor: I apply this brass ball: it receives a spark. I will now connect the prime conductor with the ground, by means of this brass rod. I continue turning the glass of the machine, and consequently continue to collect the electric fluid. I apply my finger to the conductor. You see, I cannot receive a spark, the fluid being conducted to the ground, by means of the brass rod; therefore non-electrics are conductors.

Of Insulation.

Any substance placed on non-conductors is said to be insulated. This stool has glass legs (see plate II. fig. 16.) I stand on it: I connect myself by means of a brass rod, with the conductor of the machine. As I am now insulated and connected with the conductor, you can draw sparks from any part of me, because the fluid cannot be conducted away by the glass legs of the stool, they being electrics or non-conductors.

Of Positive Electricity, or Plus; and Negative Electricity, or Minus.

You know, that when the electric fluid is in an undisturbed state, it is not perceptible to the senses, and that we are obliged to excite the electric, before we can demonstrate electric appearances; that is, we rob one body of part of its dormant or imperceptible electricity, and collect it on another body. Now that body which has a super-abundant quantity of electric fluid on it, is said to be *positively electrified, or plus*, and that body which has lost part of its natural quantity of electricity, is said to be *negatively electrified, or minus* *.

Glass, when excited, accumulates the electric fluid from the rubber, and is consequently positively electrified; now amber, sealing-wax, &c. &c., when rubbed, give off or part with some of their natural quantity of electricity to the rubber †, and are said to be negatively electrified,

* Former electricians, thinking the electricity was produced by the glass, called, what is now named positive electricity, vitreous electricity; and believing also that electricity was produced by resinous substances, named what is now called negative electricity, resinous electricity.

† This may be changed by employing a different rubber.

or

Thus you understand there is but *one electric fluid*, though it has different denominations. The *plus* and *minus* being well understood, the following experiments become obvious: they explain the manner in which the electric fluid generally dispersed is disturbed, and by what means the equilibrium is restored.

Of Electric Attraction and Repulsion.

I excite this glass tube, and electrify this pair of insulated pith-balls; that is, I electrify them positively; now they have more than their natural quantity of electric fluid on their surfaces, and the nearer the balls the more dense is the fluid; you are to understand they are separated by the fluid which is between them, and diverge till they have parted with their superabundant electricity. Now by applying my finger to them, I conduct the electricity from them, and they close. Thus, bodies electrified positively, separate (see plate 2. fig. 22 and 23.). If I electrify one ball positively and one negatively, they attract each other (see plate 2. fig. 24 and 25.); one ball having more than its natural quantity, and the other less, they approach to restore the equilibrium. I electrify two balls

nega-

negatively; they separate (see plate 2. fig. 26 and 27.); they having less than their natural quantity of the electric fluid, diverge to receive it from the surrounding bodies. I rub this sealing-wax; it is electrified negatively, or has less than its natural quantity: I apply it to the balls; that is, I I electrify them negatively, and they separate (plate 2. fig. 21.). Thus you see that bodies electrified positively, repel each other; and bodies electrified negatively, diverge, to receive electric fluid from the surrounding atmosphere. But when one body is electrified positively and one negatively, they attract each other. I rub this glass tube and electrify this ball positively; I rub the tube again, and hold it near the ball, you see the ball flies from it (see plate 2. fig. 12.), the glass tube and ball being electrified positively. I electrify the ball positively or plus, and this sealing-wax negatively; you observe the ball flies to the sealing-wax (see plate 2. fig. 11.), the one being electrified plus, and the other minus. An electric body may be excited on any part by being rubbed, and does not part readily with the fluid so collected; indeed it takes some time before the collected electric fluid is conducted away, as you will see by the following experiments: I collect a quantity of fluid on the glass

of

of this machine, by turning it; I apply my finger to it; it has not robbed it of all the fluid so collected, for it attracts the pith-ball, it attracts it again and again, and will continue to attract it till the equilibrium is restored: thus you see an electric does not part with the electric fluid excited on it at one point. Conductors part readily with the electric fluid which is collected on their surface, and from every part; I turn the glass plate, which having collected a quantity of electric fluid, it is received on the prime conductor: I apply my finger to any part of it; I have received all the fluid it had received from the glass, for you see I cannot obtain a second spark, and it does not attract the pith-ball.

I collect a quantity of electric fluid on the inside of this tumbler, by inserting a brass rod into the hole at the end of the prime conductor, and applying the end of the rod to the inner side of the tumbler; by this means I electrify the tumbler positively. Here are seven or eight pith-balls; I place the tumbler over them; you see they are attracted and repelled (see plate 2. fig. 13.); they are attracted by the superabundant electric fluid on the glass, and become positively electrified; they descend to give off their superabundant fluid; in truth, they act as conductors

 to

to conduct away the fluid collected on the electric, and restore the equilibrium.

Of Points; and the Electric Aura.

The electric fluid is received by points more readily and from a greater distance than from round or flat surfaces: this may be occasioned by the air, as it is an electric, and possibly is more condensed upon flat or round surfaces than at points; (for if a ball be made hot, it will act like a point.) I hold this ball one inch from the prime conductor; you see I receive sparks from it. I hold the point of this pin two inches from the conductor; you see this receives all the fluid, for I cannot now receive a spark on the ball.

Points will turn when electrified in a contrary direction to that in which the points are bent.

I place this brass in the hole of the prime conductor, and lay these bent points on it (see plate 2. fig. 28.); I turn the glass of the machine; you see the wires turn in a contrary direction to that in which the points are bent; if done in the dark, you would see a brush of light at each point, but from the quickness of the motion, they will appear as a circle. The electric fluid flies out from these points and electrifies the air; thus the air and points are both positively electrified,

trified, consequently they repel each other. I fix this brass, the end of which is pointed, into the prime conductor; I turn the glass; if you hold your hand near the point you feel a current of air, which is the electrified air flying from the point; this gives the sensation which is called the Electric Aura.

Construction of an Electrical Machine.

I trust, Gentlemen, you now understand, from what has been said, the construction of an electric machine. You must have an electric which you must excite to collect the electric fluid; this is the glass plate (see plate 2. *a.*). The rubbers or exciters are the cushions (see plate 2. *b b.*); and as it is found by experience, that the glass is more readily excited if the cushions are spread with amalgam, the cushions consequently are amalgamized; now by turning the glass by means of the handle (see plate 2. *d.*), the cushions, which have a spring, rub each side of the glass, and excite it. We have now collected the electric fluid on the glass plate. It is necessary to have a conductor to receive the electric fluid collected on the plate, and that the fluid may not be conducted away, this conductor, which is called the prime conductor, must be insulated (see plate 2. *c.*); and as the

electric

electric fluid is more readily received by points than by balls, that part of the conductor which is to receive the electric fluid from the electric, is furnished with points (see plate 2. *ff.*) ; and that the fluid which is collected on the prime conductor (see plate 2. *g.*) may not be carried away by points, the conductor is furnished with balls at its extremities. To regulate the strength or quantity of the fluid, the machine is furnished with an electrometer (see plate 2. *h.*).

Of Coating, Charging, Discharging, and the Shock.

The electric fluid can be compressed or condensed.

I take a plate of glass (see plate 2. fig. 10.), or a bottle (see plate 2. fig. 2.), and cover the middle of the plate on both sides with any metallic or conducting substance (tin foil is commonly used) ; this is called *coating*. The coating should be about two inches from the edge. The electric fluid is strongly condensed on the glass. If I apply one side of the coating to the prime conductor of the electrical machine, in action, holding it there some time, and connect the other side of the coating with conductors, now the plate or bottle will be charged on that side which

was

was applied to the electrical machine; if a metallic communication, or a communication with any conducting substance, be made from the coating on one side to the coating on the other side, a flash of electric light is seen, attended with a report: the plate or bottle is then said to be *discharged*. If an animal is placed so as to form part of the circuit which connects coating to coating, when the discharge takes place the electric fluid passes through him, and a painful sensation is experienced: this is called a shock. If the electric is strongly charged, it will fuse wires of iron, &c.

Explanation of the Term Charging.

By charging of coated glass, we mean the accumulating on one side of the coated glass more than its natural quantity of electric fluid, and permitting an equal quantity of the electric fluid on the opposite side of the glass to pass off; now when one side will not receive more electric fluid, and the other side does not give off any fluid, the glass is said to be charged.

Explanation of the Term Discharging.

Coated glass, when charged, contains no more electric fluid than it did before it was charged. Suppose a coated glass plate in its

natural

natural state, or not electrified, to contain on each side 100 particles of electricity, that is, 200 particles in the whole, then charge the glass, that is, apply one side of the coating to an electrical machine in action, which will give this side of the coated glass 100 particles of electric fluid, while the 100 particles on the opposite side are repelled; thus the 200 particles are on one side of the glass and none on the other: to prove this, I will make the following experiment: I insulate this plate of coated glass (in making this experiment the insulation must be complete); I apply one side of the coated plate to the prime conductor of this electrical machine, which you see is in action; you observe I cannot charge it, for it being insulated, the electric fluid cannot escape from the opposite side of the coated glass, which is applied to the machine: now I connect this side to the floor by means of this conducting rod, or I draw sparks from it with my finger, and at the same time apply the other side of the plate to the machine in action; as one side is connected with the conductor, it receives 100 particles, while the 100 particles is carried from the other side by conductors. By these means I can accumulate 200 particles on one side the coated plate, there being a way for the 100 particles to escape: thus you see

there

there are no more particles on the plate than there were before: but now the 200 particles are on one side; this is then the charged side; now one side has 200 particles on it, the other none: if I make a communication from one side to the other by a conducting substance, which can be done by the insulated discharger (see plate 2. fig. 8.), the charged or positive side parts with 100 of its particles by means of this conductor to the uncharged side, and thus the equilibrium is restored. Now the shock is that sensation occasioned by the 100 particles passing through the persons who form the circle from the charged side of the plate to the other side. I charge this bottle by holding the brass ball, which is connected with the inside coating, to the prime conductor of the machine; the machine is then put in motion; I have now charged the inside of the bottle, the same quantity of electricity escaping through my hand, and so to the floor, that is communicated by the machine: if I now touch the ball I receive a shock, as the superabundant quantity on the inside of the bottle passes through me to the outside coating, to restore the equilibrium. Thus, gentlemen, you see the method of giving a shock, is, placing the part to be shocked in the circle

formed from the charged side (either of the plate or bottle) to the other side.

Electricity and Lightening the same.

They are both collected by pointed metallic rods and by kites; there is no occasion to wait for a thunder cloud, for if you let a kite fly sufficiently high, you are sure of having fluid, as electricity is always ascending and descending.

The Electric Fluid causes the Aurora Borealis, or Northern Lights.

This glass tube (see plate 2. fig. 14.) is exhausted of great part of the atmospheric air; I apply one end of it to the prime conductor; I connect the other end of it with a conductor; my hand serves as a conductor; you see the electric fluid in its passage gives an appearance very similar to the Aurora Borealis.

Electricity decomposes and recomposes Water.

A gentleman, whose name I do not know, observed, on firing a pistol filled with hydrogen gas, by means of the electric spark, that the inside was damp, as you shall see. This brass pistol is filled with hydrogen gas and atmospheric

spheric air; I apply a spark; you hear an explosion; you feel the inside of the pistol damp. This fact he mentioned to Mr. Cavendish, who discovered that the damp was the formation of water by the union of hydrogen and oxygen, by means of the electric fluid. Electricity has also the property of decomposing water.

Of Electric Light, Noise, Odour, Taste.

I hold my knuckle some distance from the conductor; you see sparks fly to it; you also hear a snapping noise. I smell a strong phosphoric odour. I hold this glass (see plate 2. fig. 17.), on which conductors are placed at some distance from each other; I apply this brass ball (see plate 2. fig. 18.), which you see is some distance from the first piece of tin foil, to the prime conductor; it receives a spark; this goes to the next conductor, till it comes to my finger and so on (see plate 2. fig. 17. 19.) Now gentlemen, you see there is an interstice from conductor to conductor, and the electric fluid is seen passing through the spaces producing the word light (see plate 2. fig. 17.). I connect this wooden point with the conductor, and the electric fluid comes from it, giving the sensation of a gentle blast of wind. If you apply your tongue to it you perceive a subacid taste.

Of the Tourmalin, or Lapis Electricus of Linnæus.

Many precious stones are excited by heat. The tourmalin by being heated is positively electrified on one side, and negatively on the other, and at the same time.

Of the Electrophorus.

This instrument was invented by Mr. Volta. It consists of two metallic plates; the under is covered with a mixture of gum-lac, and turpentine, the upper has a glass handle. I rub this resinous plate with a cat's-skin, to excite it; I now apply the upper to the lower plate, by means of this glass handle; I touch the upper plate; I raise the plate by the glass handle; you see it gives a spark. I think Mr. Read's explanation of the action of the electrophorus very satisfactory. It is as follows:

"Place the electrophorus cake of wax, well "warmed, on the table, then rub the upper sur-"face with the palm of the hand, or with a "woollen cloth, and the cake will be electrified "negatively; which may be proved, by pre-"senting the excited surface to a pair of pith-"balls. Hence I consider the negative elec-"tricity of the cake to be incessant in its en-

"deavour

" deavour to obtain the positive electricity, and
" that nothing else can possibly restore an equi-
" librium to all its parts. But the condition or
" texture of the cake does absolutely prevent it
" from receiving at once all the electricity it
" wants.

" Yet the mode of repeating the experi-
" ments with the cake are all favourable to, and
" do in a very slow manner promote its electrical
" equilibrium.

" Let us now proceed with the experi-
" ments, and place the brass plate cover by
" means of its glass handle upon the cake, and
" we shall find, if the glass handle insulate the
" brass plate perfectly, that the plate as well as
" the cake will be electrified negatively; of
" course they have no electricity to give, but
" very eager to receive the positive electricity
" from any thing.

" I now approach the brass plate with my
" finger, and as soon as it comes within the
" sphere of the negative attraction of the plate
" and cake, the finger, though uninsulated, will
" acquire thereby the positive electricity, and a
" spark will issue from it into the brass plate,
" the quantity I will suppose is equal to both
" their wants; but it cannot, at once, as before
" said, diffuse itself into the cake, owing to its

" natural

" natural incapacity to receive it, and also some-
" what because the brass plate touches the cake
" but in a very few points.

" After the brass plate has been touched
" with the finger lying on the cake, it acquires
" the positive state of electricity, which may be
" proved in the usual way, and when it is re-
" moved from the cake by its glass handle, it
" still retains, I will suppose ninety parts out of
" a hundred of the positive electricity given to
" it by the touch of the finger, and which the
" finger will receive back again on its approach
" to the edge of the brass plate.

" In this manner a great many sparks of
" electricity may be given to and taken from the
" brass plate, by the uninsulated finger only; for
" not a particle of electricity ever comes into the
" brass plate from the cake. The cake and
" brass plates being in contrary states of elec-
" tricity, they consequently mutually attract each
" other, and their whole tendency is to unite
" their powers.

" To illustrate one of these facts, I would
" insulate a large metallic conductor, and touch
" it with a negatively charged bottle. This
" done, it is evident that the conductor must be
" in the same electrical state with that of the
" excited cake of wax. But they differ consi-
derably

" derably in their composition. Therefore it is " when I approach the conductor with my " finger, and a spark issues out of it into the " conductor, that this one touch alone will re- " store the equilibrium to every part.

" Philosophers, in their explanation of the " facts and appearances observed in the action " of an electrophorus, have, without reason, " I think, embarrassed their account with the " doctrine of repulsion: however, I can per- " ceive no repulsive power at all. The attrac- " tion of the negative surface of the cake is " therefore alone active in this case."

Electricity increases Animal Evaporation and Current of Fluids.

The Abbé Nolet has proved by many experiments that electricity increases the natural evaporation of animals, &c. I place this vessel on the prime conductor; it is full of water; the water now drops; I electrify it; you see it is now in a stream: I bled a man; the blood did not come freely; I placed him on an insulated stool and electrified him, and it came in a continued stream.

Elec-

Electricity renders opake Bodies transparent.

I pass a shock through this egg; you see it is transparent.

Electricity fires Spirit of Wine, Rosin, &c. oxidates Iron Wire, and even Platina.

I hold spirits of wine which has been warmed in this spoon, and stand on an insulated stool; I connect myself to the prime conductor. This gentleman draws sparks through the spirit; you see it is inflamed. I place this tow, on which there is some powdered rosin, on this machine, called an universal discharger (see plate 2. fig. 9.); I pass a shock through it; you see it is inflamed. I pass a strong shock through this iron wire; you see it is fused. To fuse platina requires a battery. A battery is a number of jars connected together.

A variety of theories have been formed on the electric fluid—I shall give that of Franklin, being the most approved.

Franklinian Theory.

This theory supposes that all the phenomena of electricity depend on a fluid *sui generis*, extremely

tremely subtle and elastic, dispersed through the pores of all bodies, by which the particles of it are as strongly attracted as they are repelled. When bodies possess their natural share of this fluid, they are then said to be in an unelectrified state, but if they either acquire an additional quantity or lose some of their natural share by communication with other bodies, they are said to be in a state of electrification. In the former case they are said to be positive or plus, and in the latter negative or minus. This theory divides all bodies into two classes, electrics and conductors. The electric fluid is supposed to move with great ease in the latter, and with great difficulty in the former. Moreover, electrics are supposed to contain always an equal quantity of electric fluid, so that there can be no increase of this fluid to one side of a glass without a proportionate decrease or loss on the other, and *vice versâ*; and as electrics do not admit the passage of electricity through their pores, there will be an accumulation on one side and a corresponding deficiency on the other; and when both sides are connected together by conductors, an equilibrium will be restored by the redundant fluid rushing from the overcharged side to the exhausted one.

Method of giving the Electric Spark.

Connect a chain to the electrometer, F, of the machine, which must also be connected to the brass end of the director; hold the glass part of the director in your hand, and the brass ball at a small distance from the part that is to have the spark applied to it (plate I. B,); the nearer the electrometer is to the prime conductor the less is the spark, and *vice versâ*. If the part electrified is rubbed quickly with the brass ball, the sensation is more agreeable.

Method of drawing Sparks.

Let the person stand on the insulated stool, and connect himself to the prime conductor of the electrical machine by means of a brass rod. Hold the brass conductor in your hand, and draw sparks from any part of the person insulated (plate II. 15.). If a large brass ball with a wooden handle is used (plate I. 13.), the sensation occasioned by the fluid is very pleasant. In some cases it is necessary to draw the spark from the parts affected with the fingers, especially in knee cases. When it is necessary to draw sparks through a part, connect a chain to the prime conductor and to the insulated director, let the patient sit on a chair placed on the insulated

stool,

stool, direct the brass ball of the director to one part and a conductor to the other part, and a spark will pass through the part from one conductor to the other. Indeed Mr. Cuthbertson's machines are so powerful, that there is no occasion to insulate the patient.

Method of applying the Aura to the Eye, &c.

Sit on the chair on the insulated stool; let the chair be connected with the prime conductor by a rod (pl. II. &c.); hold the wooden point (pl. I. 10.) in your hand, and by bringing the point near the part to be electrified, the aura will be thrown on the part desired*. If the aura is to be drawn from a part, let the person who is to be electrified sit on the insulated stool, hold the wooden point in your hand, and apply it to the part, and the aura will come from the part to the point of the wooden conductor. You may also throw the aura on a part, by connecting a wooden point to the insulated director, which is to be connected to the electrometer of the machine by the chain;

* It is the electric fluid goes from the point to the eye in a stream:—the electrified air gives the sensation of wind. (See p. 20.)

hold the glass part of the insulated director in your hand, and direct the point to any part you wish.

Method of giving a Shock.

Make a circle from the inside coating of a charged jar to the outside coating, the part or persons to be shocked forming part of the circle. No. 2. plate II. is a Leyden jar or bottle, covered with tin foil within and without as high as *i*. A brass rod is connected to the inside coating, on the top of which is a brass ball (pl. II. *i*.); this ball is brought in contact with the prime conductor (plate II. *g g g*.). Plate II. fig. 3. is the regulating electrometer, the top of which is furnished with a brass ball. The brass part of the electrometer is insulated by being placed on a glass rod, which is received into a brass cap, screwed into the wood at the bottom. The ball of the electrometer can be moved by means of the screw at the bottom to or from the conductor: this is to regulate the strength of the shock. A chain or metallic wire is connected (plate II. *m m m*.) to the brass of the electrometer; this chain is also connected to the brass part of the insulated director (*n*.). The glass part of the director is held in the hand (*o*. plate II.). The ball of the director is applied to the heel (pl. II. *p*.),

A di-

A director is held in the upper hand (*q*.), the brass ball of which is applied to the leg (*r*.). A chain (*s s*.) is connected to the brass part of this director; this chain is also connected to the outside coating of the jar (*t*.) A circle is thus formed from (*i*.) the inside of the jar to (*t*.) the outside of the jar, giving a shock through the the leg from the heel to the top of the leg. The nearer the brass ball of the discharging or regulating electrometer is to the prime conductor, the slighter is the shock, as there is not so much electric fluid collected in the jar, but the shocks are more frequent.

When you want small shocks to pass through any thickness of clothing, you must use the glass tube (plate I. fig. 12.). It is about seven inches long, and half an inch wide; it is hermetically sealed at one end, is half filled with brass filings, and coated with tin foil to the same height on the outside; a wire is connected with the filings, which projects an inch from the mouth of the tube; this is placed into one of the holes of the prime conductor, and the circle formed as before.

I am convinced, by experience, that electrical machines made with glass plates are the best: they are at all times superior in acting

power,

power, and are applicable to medical as well as philosophical purposes. I shall give a description of that which I use:

Description of Mr. Cuthbertson's Plate Electrical Machine.

Pl. I. fig. 1. A, C, D, represents the machine with its prime conductor in a position for simple electrification. C, D, is a square piece of mahogany, which forms the basis of the machine, about two feet long, one foot broad, and an inch and a half thick. *h*, *g*, is a straight wooden style, glued fast to C, D, at *g*. *k*, *l*, is another style, not glued fast as the former, but fixed by means of three screws, one at the front to draw it close to the base C, D, of the machine, and two underneath the bottom to draw the style downwards upon the bottom, to secure it against any motion. *m*, *n*, is a cross piece, which forms the top of the frame, screwed fast to the two styles by means of two brass screws, which pass through the cross piece into *h*, *k*, by which means it is drawn very tight, and secures it against motion. *o*, is the spring frame which contains the upper pair of rubbers, and is screwed to *m*, *n*, by means of a screw, P. *q*, is also a spring frame, which contains the under pair of rubbers. *r*, *r*, is prepared silk

silk sewn to each rubber, seen separate at fig. 2. W, *t*, *u*, is the prime conductor. *w*, *x*, is a solid stick of glass, which serves to support and also insulate the prime conductor; the end, *w*, is mounted with brass, which screws into the centre of the large ball of the conductor. Y, *y*, is a round glass plate fixed upon an axis; the plate has a hole in the centre, and the axis has a brass bush fixed upon the middle, and is turned with a shank, having a male screw which nearly fits the hole in the centre of the plate; this axis is put through a hole in the centre of the plate, till it stops at the shoulder, against which the plate rests, and is held fast by means of a second brass bush; one end of the axis moves in a hole in the style *g*, *h*, and the other end goes through a hole in the middle of the style *l*, *k*, and is turned by means of a winch Z, which causes the plate to turn and pass between the rubbers fixed at the top and bottom of the frame of the machine.

Construction of the Rubber.

Fig. 3. represents the spring frame of the upper cushions on one side, and the silk for distinction sake is taken off. P, is the screw seen at P, fig. 1. which passes through *m*, *n*, and screws into *o*, by which it is held fast in its

proper

proper position. Fig. 2. represents a single rubber with the silk flap; this is covered with red leather and stuffed with slips of woollen cloth, then a piece of silk properly prepared and cut to the shape, as may be understood by the figure; it is screwed fast to the middle of the rubber, which is fixed by means of moveable screws to *o*, *a*, seen at *b*, without the silk. *o*, is a long brass screw which passes through the side of *o*, *a*, and screws into its opposite side; by turning this screw one way it will draw the rubbers close and make them press the plate, and by turning it the other it will loosen them; as this screw head is difficult to get at and turn with the fingers, there are holes made at the side of the head of the screw, in which the end of a wire may be put, and it is then easily turned; to fix this to the frame of the machine, as is represented fig. 1. open the rubbers to about the width of half an inch, then slip them upon the plate so that the top by *o*, comes close under the cap of the machine fig. 1.; then put in the long screw P, through a hole in the cap of the machine, and screw it into the top of the frame of the rubbers very tight (taking particular care that the plane of the rubbers apply to the plane of the plate), this will hold the rubbers in their proper place. *m*, *o*, is a wire, from which proceeds two or three

silk

silk strings fastened to the edge of the silk flaps, which serves to keep them from sticking to the edge of the plate while turning.

The rubbers, *q*, are constructed exactly the same as these already described, but are different in their application to the frame of the machine. The piece D, fig. 4. which is the bottom of the frame for the under rubbers, is cut open from one side quite to the centre of the piece, and at the bottom of the frame of the machine is a piece of brass set upright, with a male screw, to which is fitted a nut with a female screw; it has holes at the edge for the convenience of screwing it tight, by means of a wire; the two sides with the rubbers being fixed to D, C, fig, 1. it is placed upon the bottom of the machine, so that the upright brass pin goes into the groove in D, and there screwed tight by means of the female nut.

Construction of the Prime Conductor.

W, *t*, *u*, is the prime conductor; *w*, is a large brass ball with a shank about an inch long fitted into the cylindric part, so that it may be turned for the purpose of setting the hole, which is at one side of the ball, in any position that the experiment may require: this hole will be found

 useful

useful for various purposes. The conductor is supported and insulated by the solid glass cylinder *w*, *x*. It may at any time be taken to pieces by unscrewing the cylindric part of the conductor from off the large ball *w*, where a square nut will appear, which being unscrewed, *w*, *x*, may be taken out; one end of the two receiving arms or tubes is screwed into the large ball at *w*, one having a left-handed screw, so that the weight of the arm may be borne by the shoulder, to hinder it falling down by its weight, the two cross pieces fronting the plate, with two or three points to receive the excited fluid, are each screwed on to their respective arms, the one with a right-handed screw and the other a left-handed, for the same purpose as the screws at the other end of the arms. The end *x*, of the glass cylinder is mounted with a male dove-tail, which fits into a female dove-tail fixed to the frame of the machine, opposite to the hole in which the axis moves.

Construction of the Regulating Electrometer.

E, F, fig. 1. represents the electrometer screwed to the machine as when in use; it is a solid

solid stick of glass, mounted at both ends with brass. The mounting at E, has a hole near the middle, through which a screw passes, and screws it fast to the end of the bottom of the machine, as is represented at E. This kind of electrometer is very serviceable in medical cases to govern the degree of strength in either shocks or sparks, and also in philosophical experiments for the same purpose: it is screwed fast to the foot of the machine, to regulate its distance from the knob of the conductor; the screw has holes on its edges, wherein the end of a wire may be inserted to scew it tight when it is at its required distance from the conductor.

The Method of making Amalgam.

Take one part of tin and zinc, melt them in a crucible, and pour them on two parts of mercury, which is put into a wooden box made for the purpose. The box must be well closed, and confined within a leather case. Shake the box till the metals are cold. The amalgam is then to be pounded in a marble mortar to a very fine powder, and then mixed with a sufficient quantity of hog's lard, to make it into a paste.

How to clean, amalgamize the Rubber, and to make the Machine in good acting Order.

Unscrew P, fig. 1. plate I. and take it out, then turn the winch *z*, a little towards *k*, and the rubbers will come out from under *m*, *n*, when they may be drawn off from the plate; then take out the under rubbers, by means of a wire turn the round nut at the bottom till the rubbers are loose; when the winch is turned they will come out of their places, unhook the two silk strings, and the rubbers may be released from the plate as the others. To separate the rubbers, take out the screw O, fig. 3. plate I., then the side pieces with each rubber may be separated so far that they will admit of sufficient separation to be cleaned and amalgamized. If the rubber and the silk be not very dirty, slight rubbing off with a dry linen cloth will be sufficient, and then a little amalgam may be spread very thin on the part, *i*, fig. 2. just covering the seam, but not rising to any thickness above the silk. It must be spread on with a flat knife or such like instrument without any lumps or inequalities. If the old amalgam should be very thick and unequal on the part *i*, then it is necessary to scrape it off and to put on fresh amalgam. When there is great exactness observed to lay it on of its proper thickness,

ness, the machine will act the better: it ought to be laid on of such a thickness that the surface of the amalgam is equal with the surface of the silk, and no openings or separations between the amalgam and silk. This being done to all the rubbers, put them again into the dove-tails, and put the screw O, into its place, then the glass plate must be cleaned with a little whiting on a linen rag, or, which is better, powder-blue: then put one pair of rubbers into their places as they were found, and give them their proper pressures by screwing O, tighter, then turn the plate briskly round, and hold your finger or side of your hand close to the plate at the end of the silk flaps (the conductor being previously taken away), and sparks will fly very abundantly to it, if not, screw the screw O, till you find that it does, and that it does not increase by screwing tighter. Then put in the other pair of rubbers, and follow the same rule: wipe the greasiness off the plate which is occasioned by the amalgam; set the conductor into its place, and it will be found to act very powerfully: when its greatest acting power is required, then it is necessary to prove by experiment, that each pair of rubbers excites the plate equally; to prove this, take fig. 6. which is a Leyden phial, with its inside wire bent so, as may be understood by inspecting the

the figure; take hold of the coated part in the hand, and hold it so that the part *a, a,* of the wire as nearly touches the glass plate as possible, just at that part where the silk flap ends, then turn the winch, and the phial will charge and discharge itself from the end of *a, a,* to the outside coating in one revolution—Note the number of discharges from a certain number of revolutions: if it is a single plate machine of two feet diameter, it will give two discharges in one revolution; then hold it to try the action of the other rubbers at *q,*; if this causes the same number of discharges in one revolution, or in a certain number of revolutions, as the other rubbers, then their acting power is equal, but if this should not happen, then the pressure of the rubbers must be increased or decreased, or the face of the amalgam altered, till they are equal. A two feet plate machine never requires more friction than that which requires an eight pound weight (hung upon the winch when in an horizontal position) to move it; if it requires more, it is not properly amalgamized.

The machine which I have described, is that which is most in use, but there are many others made of various sizes and mountings.—An electrician will observe, that the electrical machine just described, only acts positively. They

are

are made to act negatively as well as positively, but as acting negatively is not required for medical purposes, which is the object in view, a description of the negative part unnecessary.

GENTLEMEN,

I SHALL not attempt to give any theory of the action of electricity in disease—you will be able to judge of its effects by the following cases:

CONTRACTIONS.

I have tried electricity in a great variety of contractions, and have only found it serviceable where contraction depended on the affection of a nerve.

A woman had a contraction of the little finger, of some months duration; I gave a strong spark on the ulnar nerve, and it was immediately removed. I have applied electricity in similar cases, but without effect.

In Cases of RIGIDITY, *Electricity is of great Use.*

A young man, aged 20, had a rigidity of the lower extremity, attended with great pain of the knee; a variety of applications were tried without effect; I gave him strong sparks on the knee, and

and drew the fluid from the groin to the toe, and from the tuberosity of the Ischium to the foot, twenty minutes a day, for a fortnight; this did not produce any motion in the knee, but occasioned a slight action in the toes. In a few days after, a cramp was felt in the foot, which was followed by a general spasm of the lower extremity. I continued to electrify the parts, and the patient gradually recovered in the course of two months.

I have tried electricity in three cases of wry neck; in one of these I succeeded, by drawing strong sparks through the Sterno-cleido mastoideus, and from the upper insertion of this muscle to the Trapezius, conceiving this case to be a nervous contraction. Although there is no doubt but wry neck may be produced by other causes.

Sprains, Relaxations, &c.

A young lady, in consequence of a fall, sprained both her ankles; the usual applications had been tried for eight months; there was no pain or inflammation at the time I saw it; she could move the flexors and extensors of the foot, but could not walk. I electrified the part ten minutes a day, for a week, at which time she could walk by the assistance of crutches. I electrified her twenty minutes a day, for three weeks

longer, at which time she could walk without assistance.

A person, aged 40, sprained her right ankle by a fall, three weeks before I saw her. I electrified the part ten minutes a day, for a fortnight, by which time she recovered.

I think electricity should he used in every case of relaxation, or sprain, but not till the inflammation has subsided.

Indolent Tumors.

Electricity is of service in dispersing tumors of this description. I have succeeded in several cases, though in the greatest number I have been unsuccessful. The method of electrifying them, is giving strong sparks, and passing slight shocks.

I have tried electricity in the goutiere, or Derby neck, without success.

I have succeeded in the cure of schirrous testicle in two or three cases, by strong sparks and slight shocks; however, in this disease, electricity is not always successful.

There is no question but electricity will sometimes disperse a scirrhus in the breast, and assist the action of mercurial frictions.

There are many cases on record, of schirrous breasts

breasts being cured by electricity; yet, although I have tried it in several cases, I have only been successful in one. This was a young woman, aged 20, and the complaint seemed local.

Ganglions.

A labourer had a ganglion, as large as a pigeon's egg, on the wrist; the usual methods had been tried for six weeks, during which time it increased in size. I rubbed the part with mercurial ointment and camphire, and electrified it with strong sparks ten minutes a day, for three weeks, by which time it gradually dispersed.

A lady had a large ganglion on the extensor tendons of the foot, which was rapidly increasing; this was cured by sparks in three weeks.

I have succeeded in several other cases of ganglion, but have often been disappointed.

Chilblains.

A boy, aged six years, had chilblains on three of his toes; the little toe had not the least feeling. Two of them were cured by sparks, applied ten minutes a day, for two weeks, and the little toe now began to recover its feeling, and in two weeks more was perfectly cured.

A girl with chilblains on her hands and fingers cured in a week by sparks. Electricity is also a good preventative against chilblains.

Epilepsy.

A boy, aged 14, had been troubled with this disorder two years, he thinks in consequence of carrying heavy loads on his head. He had four or five fits a day.

First day, drew strong sparks from the head for five minutes; no return of the fits that day: next morning he had one fit; I continued to electrify him for a week, two last days of which, had had no fits; on ceasing, the fits returned; I then continued the electrification for three weeks, the two last of which he had no fits. He then went into the country, and I flattered myself he was cured; in a year he returned, and said, that in a fortnight after he left town, the fits returned as bad as ever. I now electrified him with sparks and shocks for a month, without the least success.

I have had two other unsuccessful cases of epilepsy. In one of these, the gentleman had an uncommon degree of perseverance. I electrified him for ten weeks, without success.

Deafness.

A young lady, of scrophulous habit, had been deaf three years; she could not hear, so as to hold a conversation. I threw sparks on the Mastoid process, and round the Meatus auditorius externus, and drew them from the same parts of the opposite side with my fingers, twenty minutes a day, for three weeks, when she could hear perfectly well.

A gentleman, aged 50, had been deaf nine months; I electrified him eight times, when he recovered.

A gentleman had been deaf six months, could not hear me speak at a yard distance. I electrified him the first day, twenty minutes (as in the first case); he could now hear me at twenty yards distance. I continued to electrify him every day, for three weeks, and he gradually recovered.

A gentleman had been deaf three years, was electrified twenty minutes, when he could hear perfectly well, and continues to hear. A year after this, he brought a friend to be electrified,

who

who had been deaf six months; I electrified him six weeks, without success.

A girl, aged 11 years, became deaf immediately after the hooping-cough, and continued so four years. I electrified her for six weeks, at which time she perfectly recovered.

A gentleman, aged 74, had been deaf many years: I electrified him ten minutes, which for an hour seemed to increase the disorder; however, in the evening he was better than before he was electrified. The same effect took place the next day: I continued to electrify him ten minutes a day, for a week, by which time he could hear the birds chirrup, which, he said, he had not done for many years before. At the end of six weeks he was considerably better, but on discontinuing the electricity for a month, the deafness returned. I electrified him repeatedly after this, and always with success, but on discontinuing the electricity, the deafness always returned.

Although electricity is of great importance in deafness, yet, from my experience, I find that not more than one in five are permanently cured.

I have

I have tried various ways of electrifying for deafness, and have found none so efficacious as that made use of in case the first. I sometimes, however, draw sparks from the tympanum, by introducing a wire, coated with sealing-wax, into the meatus auditorius externus.

Opacity of the Corneæ.

A girl, aged six years, had an opacity of the corneæ of both eyes, in consequence of the small-pox, which was so considerable that you could not observe the pupils; she could tell when a candle was brought into the room, but could not distinguish objects; she had been in this state two years; the usual applications had been tried. I drew the aura with a wooden point from the parts affected ten minutes a day, for fourteen days, continuing the applications, without any visible effect; during this time, the electricity did not give any pain; but on continuing it, the parts became very irritable, much pain being occasioned by the fluid. I now observed a visible alteration, the girl began to distinguish objects, and by the end of three months, a cure was nearly effected. I now electrified the eyes occasionally, and at the end of six months she was perfectly recovered. I have had other successful cases of opake corneæ, though I have been unsuccessful

successful in many. I have observed that those opacities occasioned by the small-pox, yield more readily to electricity than those occasioned by other causes.

Gutta Serena.

I have electrified a variety of persons, of different ages, who had been afflicted with this disease, and always without success: a friend of mine, however, had the good fortune to succeed in a case of some standing, by the aura; and there are many cases on record, of gutta serena being cured by electricity.

Amenorrhæa, or Interruption of the Menstrual Discharge.

A young lady, aged 17, who had menstruated twice, had no return for eight months: her face was of a yellowish colour, the abdomen swelled, pain in the back and loins. I electrified her with sparks for two days, then gave six small shocks with the coated glass tube from the sacrum to the pubis, from the anterior inferior spinous process of the right ilium, to the inner side of the tuberosity of the left Ischium, then from the pubis to the heel, and from foot to foot. I increased the strength of the shock, and gave ten

ten each day, for three weeks, when she menstruated, and continued regular.

A widow lady, aged 30, had not menstruated for three months; gave ten shocks a day, as in the first case, for two weeks, when she menstruated, and continued regular.

A young lady, aged 19, was subject to hysterics, had not menstruated for a year. I electrified her, as in the first case, for six weeks; I now discontinued the electrification, thinking it would not be of service in this case, as I uniformly found it answer in much less time. However, in two or three days the menses returned, and the hysterics have not been so frequent since this period.

An unmarried lady, aged 36, had not menstruated for thirteen months, had frequent sense of lassitude, pain in the head, back and loins, pale face. I electrified her, by drawing sparks from the region of the uterus, ten minutes a day, for three days. I now gave slight shocks, six a day, for fourteen days; this fatiguing her very much, I advised her to discontinue the electricity for a week, before the expiration of which time, she menstruated, and continued to be regular.

 In

In two months her health was perfectly re-established.

A girl, aged 21, had not menstruated for two months. I gave her ten shocks, as in the first case, and she menstruated in the course of the day.

In many cases of suppressed menstruation, the return of the menstrual discharge has been preceded by fluor albus.

I have had a great variety of cases of suppressed menstruation, and have generally found electricity successful: but in retention of the menses, I have repeatedly tried it, without success.

It is a curious fact, that an electric shock given to a healthy woman, will frequently occasion an immediate discharge of menstrual fluid.

Knee Cases.

A young woman, aged 19, of a florid complexion, had great pain in the knee joint for upwards of two years; blisters and leeches were applied, without effect. I electrified the knee, by rubbing the ball of the insulated director over it, fifteen minutes a day, for three weeks, by which time she was perfectly recovered.

A boy

A boy had swelling and pain in the knee joint of upwards of a year's standing. I insulated him, and drew sparks from the parts affected with my fingers, ten minutes a day, for a month. The swelling continued; however, there was no pain: I saw him three months from this time, and the pain had not returned.

A child, aged three years, had pain in the knee, which was puffy, the condyles enlarged, so weak that she could not walk without assistance. I drew sparks from the knee with a large brass ball with a wooden handle, ten minutes a day, for two months, when she could walk without assistance, and did not feel the least pain. The puffiness was removed, but the condyles remained enlarged.

I have succeeded in several other knee cases, yet have been unsuccessful in at least nine cases out of ten, by electricity alone.

Chronic Rheumatism.

A gentleman, aged 47, had pain in his arm at the insertion of the Deltoid and Brachialis internus muscle, and at the insertions of the muscles of the Scapula; had great pain when warm in

bed. I electrified him two minutes a day, for ten days, by which time he was perfectly recovered.

A native of Africa, aged 45, had been in this country a considerable time, had excruciating pain at the insertion of the muscles of the Scapula, and at the upper and lower insertions of the Biceps, and at the insertions of the muscles of the thigh and leg. I drew strong sparks from the parts affected, fifteen minutes, the first day; the pain much less after the electrification; more pain this night than ever; second day, electrified him fifteen minutes; third and fourth day, the same, little alteration; fifth day, I electrified him twenty minutes, had a better night and considerable perspiration; continued to electrify him twenty minutes a day, for thirty days, by which time he was perfectly recovered: three weeks after this he caught cold, and his pains returned in a slight degree; was cured by being electrified fifteen minutes a day, for a week.

This man, before he was electrified, had taken the usual medicines given in rheumatism for two months, without effect.

A lady, aged 60, had pains at the insertion of the Gemini, Pyriformis, &c.; indeed the pain

seemed

seemed to proceed from the Trochanter major to the Trochanter minor. She had not been able to walk for three weeks, and was carried from the coach to my electrifying room. I placed her on an insulated chair, and drew strong sparks from the parts affected, for ten minutes; this gave her great pain, but as she could now move her thigh, I continued to electrify her ten minutes longer, when she was able to walk; she could not sleep this night, the pain was so considerable; however, she walked to my house next morning; electrified her twenty minutes; slept great part of this night, having less pain and profuse perspiration. I electrified her twenty minutes a day, for three weeks, by which time she was perfectly recovered.

A young woman had rheumatism in the upper part of the muscles of the Os femoris, had been in a most dreadful state for six months, had taken guaiacum, large doses of opium, used mercurial frictions, and liniments; the parts had been blistered, and leeches had been applied, without effect. I drew sparks through the parts affected, twenty minutes a day, for six days; this gave her some relief, while the parts, as she expressed it, were benumbed; but the pains always returned in a few minutes, with an equal degree

degree of violence. I now passed twenty small shocks; this gave pain; but when the irritation subsided, she could walk better; much pain at night: next day gave her twenty shocks; a tolerable night, with little pain: third day, twenty shocks; a good night, some pain: fourth day, twenty shocks; slept well, no pain: fifth and sixth day, twenty shocks, and no pain: did not see her for three weeks, when she came to return me thanks, saying she was perfectly recovered, and had not any pain since she saw me. She was now in service.

A gentleman had pain in the foot at the insertion of the Tibialis anticus, at the upper insertion of the Rectus, Sartorius, and contiguous muscles. He could walk, but, at times, walking gave him great pain: when warm in bed, he said the pain was intolerable; had been in this state two months; had not taken any medicines: electrified him twenty minutes a day, for twelve days; during this time the pains were felt in various parts, sometimes in one place, and sometimes in another. However, at the end of this time, he was perfectly recovered.

A man, aged 40, lost the use of one side, in consequence of the rheumatism; his pains were

were continual, sometimes at the insertion of one muscle, and sometimes at that of another; when warm in bed, the pain was general; he had taken the various medicines given for rheumatism, without effect. I insulated him, and drew sparks for ten minutes; had not so much pain, but a very indifferent night: second day, I electrified him fifteen minutes; a better night: third day, I electrified him fifteen minutes; could walk with a stick, and use his arm; a good night: fifth day, I electrified him fifteen minutes; much better: sixth day, could walk without assistance: seventh day, fifteen minutes, and no pain. I continued for ten days, by which time he was perfectly recovered. This cure was effected in the year 1798. I have had frequent opportunities of seeing this man, and he says, he has had no return of the rheumatism since that period.

A man, aged 55, lost the use of his right arm, in consequence of laying on deck in a damp night; he said he was in continual pain, but when warm in bed he was almost mad. I insulated him, and drew sparks from the affected parts twenty minutes; he could now move his arm, and felt very little pain; he was obliged to leave town in a few hours, and did not return for eight days, when he called on me, and said, that

that the night of the day he was electrified he had not slept, being in continual pain; that the perspiration was immoderate, but from that time he had not any return of pain.

A labourer lost the use of his right arm from rheumatism; he had been in this state one month. I drew sparks from the parts affected for ten minutes; he could now lift a six pound weight: second day, I electrified him ten minutes; some motion in the arm: third day, ten minutes; could move his arm to his head, not so much pain in the day, but pain when warm in bed. I continued the electricity ten minutes a day, for ten days, when he returned to his work, being perfectly recovered.

I have been successful in a variety of cases similar to the last. They were most of them gardeners, and attributed their complaints to exposure to the morning dews. The recent cases were cured in two or three days; but where the disease had continued for three or four weeks, it was necessary to electrify them ten or twelve days.

I have succeeded by electricity in the cure of upwards of two hundred cases of chronic rheumatism; in most of them the pain seemed to be

at the insertion of muscles, and was most considerable when warm in bed. The first electrification sometimes gave relief, and the patient could move the part with less pain; but it frequently returned in a few hours, and seemed to be more acute on that night than it had been before. A considerable perspiration was generally produced, sometimes even during electrification. I have had several cases of pains, wherein I have been unsuccessful, and which were supposed to have been rheumatism. But in these cases, although I could not perceive any nodes, yet the pain seemed to proceed rather from the periosteum or bone, which made me conclude they were venereal. In the following case I found my conclusions were just:

A gentleman, aged 47, had pains in his arms, thighs, legs, and head; sometimes in one part, sometimes in another; had been in this state two years: the pain was most considerable when he was warm in bed, but did not seem to be particularly at the insertion of any muscle. I electrified him with sparks, which increased the pain. I examined the parts affected, but could not discover any disease of bone. He desired me to continue electricity for a week, but it evidently increased the pain. He was positive that

it was not venereal, and would not submit to a course of mercury. A few months after this he died. I was permitted to examine the body. The os frontis, the parietal bones, and the tibia, were diseased. There could be now no question but the pains proceeded from venereal causes.

Acute Rheumatism.

I have tried electricity in six cases of acute rheumatism, and succeeded in one, by throwing the aura from a wooden point. This was a disease of a month standing. I applied the aura ten minutes a day, for a fortnight; then every other day, for ten days; by which time the person recovered.

Palsy.

A gentleman, aged 30, lost the use of the lower extremities, two years before I saw him, (in consequence of lying in a damp bed); he had not the least feeling in them. I insulated him, and drew strong sparks from the sacrum, and in the course of the great ischiatic nerve, for ten minutes. I now passed ten small shocks from the sacrum to the popleteal nerve, then from the sacrum to the toes: I continued this plan for three weeks; I increased the shock; in six weeks he could move his legs; the shock now gave

some

some pain; I increased the shocks to twenty each day. I used the small tube in this case. He had been electrified two months, and could walk with the assistance of crutches. There was now a sudden change of weather, the cold was intense. In the course of a week the paralysis returned. I electrified him with sparks and shocks for a month, but he did not receive the least benefit. Electricity was now discontinued; this was in December: in spring, feeling gradually returned, and in three months he was perfectly recovered. He had not taken any medicine, nor had any applications been made use of, from the time electricity had been discontinued.

A labourer, aged 47, was seized with great pain in the umbilical region; he had been subject to epileptic fits. He said he fell on his face, and did not know whether it was a fit or not. He continued senseless for two days; when he recovered in some degree his intellectual faculties, he had lost the use of his right side; he could not articulate; he could not see with his right eye, nor hear with his right ear. This was in November. By March he could speak, but scarcely intelligible, and now had some motion in his right leg, but could not move his right arm. The muscles of his face were drawn downwards; he

could see a little with his right eye, but could not hear on this side. I gave strong sparks, for ten minutes a day, for three days. On the third day he felt the parts warmer, and a tingling. I increased the time of electrification to half an hour; in six days from this, he could speak so as to be understood. I continued the sparks half an hour a day, for ten days; he could now see with his right eye, and heard better: he could also use his right arm. From the time he fell, he had strong fits every third or fourth day. He had not had a fit from the time he was electrified, till the twentieth day: he said he then felt an approaching fit, for that he saw white and black spots float before his eyes. His eyes became fixed. In this state I electrified him with sparks; he recovered in less than a minute. Two days after this, he had again symptoms of an approaching fit, and was electrified with the same good effect. He was electrified three times a day, for three weeks, during which time he had no return of the fits. He was now so far recovered as to be able to work. He could hear, but had some defect in his speech. The muscles of his face remained somewhat contorted.

A gentleman, aged 21, had been under a

course

course of mercury for a venereal complaint; a salivation could not be produced. Had pain in the hip joints, and in the lower extremities. In two months from this, the parts became cold. There was not now any pain, and in a few hours the parts became perfectly paralysed. He had been in this state one month when I saw him. I gave him fifteen strong shocks, for four days, which he did not feel. On the fourth night, he felt a glowing warmth in the part. The fifth day I gave twenty shocks; he now began to feel them: sixth day, twenty-five shocks; had some pain this night: seventh day, thirty shocks: eighth day, thirty-five shocks; these gave him great pain; could now move his legs: ninth day, forty shocks; these giving so much pain, I gave but thirty on the 10th day: eleventh day, thirty shocks; better: twelfth day, thirty shocks; not so much pain when shocked: thirteenth day, twenty-five shocks; little pain when shocked. I continued to electrify him with twenty-five shocks a day, for ten days. I decreased the number of the shocks. He had now no pain when shocked. He was perfectly recovered, in two months from receiving the first shock. I passed the shocks, as in the first case.

A gentleman, aged 18, caught cold, had a considerable pain in all his limbs; the pain continued a fortnight, when he began to lose the use of the lower extremity. The usual remedies given in these cases were tried for four months, without success. I was desired to electrify him. I drew sparks from the parts affected, twenty minutes a day, for a month; he did not feel the sparks, nor had he received the least benefit. I now began with eight shocks a day; first day passed the shock from the right foot to the left foot; from the lumbar vertebra to the right foot, and then to the left; from the dorsal vertebra to the right and left popliteal nerve. The shocks moved the limb (which is always the case), but he did not feel them. I increased the number of shocks four or five a day, till I came to fifty. He now began to have some feeling. He had received shocks for three weeks. He could move the diseased parts, had much pain in them, and which was considerable when shocked. In a fortnight from this, he could walk with the assistance of crutches. I now decreased the number of the shocks gradually. He had not any pain on receiving the shocks. In six weeks from this, he was perfectly recovered.

A young

A young man was bruised in the arm by some timber falling on it. The injury was on the inside; he could not move it, nor had it any feeling, though the natural warmth continued. I passed small shocks from the neighbourhood of the brachial plexus of nerves to the fingers. I passed ten shocks a day, increasing them gradually to twenty. In five days he began to feel. I continued the shocks for three weeks, by which time he was perfectly recovered.

An old gentleman had a tingling sensation from the shoulder to the end of the fingers. In two days from this, he lost the use of them. I drew strong sparks from the arm and fingers, twenty minutes a day, for a week, by which time he was perfectly recovered.

A man had hemiphlegia of the right side, in consequence of working at a white lead manufactory. He had used mercurial frictions, but without effect. I electrified him by giving shocks, as in the former cases, for six weeks, by which time he was perfectly recovered.

I have had three other cases similar to the last, in which electricity succeeded; in two of

these

these the use of mercury was continued, during the cure.

A foreign gentleman had hemiphlegia, which seemed to have been occasioned by intense study. He had taken medicines before I saw him for six weeks, and had received some little benefit; however, the muscles of the face were drawn down; he could not speak so as to be understood, nor could he walk or use his arm. I began by giving sparks; then small shocks, which I increased gradually. The shocks gave him great pain. In this case there was a great rigidity in the parts affected. In this, as in many cases of palsy, the spirits were much affected; he frequently burst into a flood of tears. The first good symptom was a composure of mind. I continued the electricity, as in the former cases, for six weeks, at the end of which time he could talk perfectly well, could walk three or four miles, and had the perfect use of his arm.

Gentlemen, I have had several other successful cases of paralysis, yet, from my experience, I have found that not more than one in fourteen have recovered by electricity. I have electrified in various ways, by giving and taking sparks,

sparks, by small and strong shocks, by drawing the fluid with points, and I find that moderate shocks with sparks the most successful mode of electrifying. I will now give some unsuccessful cases:

A girl, aged nine years, in apparent health, was seized in the day time with a general paralysis. She had immediate medical assistance, and seemingly with good effect, for in three weeks she could speak so as to be understood, and in six weeks could walk; she recovered the use of her left upper and lower extremities; the muscles of the right upper and lower extremity were contracted; she could move her right arm, but could not use it; she could use the left lower extremity, but imperfectly: I had not seen her from this time for two years, when I met her by chance; the diseased side had grown equally with the other, so that, growth excepted, I found her in the same state she had been in two years before. Every application, except electricity, having been tried, I electrified her with sparks, every day, for two months, without the the least success. I now gave ten small shocks a day, for two weeks; I increased the strength and number for two weeks more, without success. I discontinued the electricity for three

 months.

months. I now electrified her again for six weeks, and she still continued in the same unfortunate state.

The uncle of the girl, mentioned in the last case, was attacked with hemiphlegia. The various remedies were used, without success, electricity not excepted: though this man did not recover, still he received much benefit from the sea air.

A child, aged three years, lost the use of his lower extremities: I electrified him with strong sparks for a month, without any good effect: I now tried shocks, with as little success.

I find children are very subject to this disease, and within this year I have been successful in two or three cases, but I am sorry to say, I have been unsuccessful in several.

I trust, Gentlemen, from the above cases, you will see the utility of applying electricity in disease.

LECTURE

ON

GALVANISM.

GENTLEMEN,

I Apprehend it is the duty of every medical man to make himself perfectly acquainted with any discovery, where there is the least probability of its being successfully applied in disease. With this view I have attended to the phenomena of the Galvanic influence, and have endeavoured to select the most important discoveries that have been made in it, and shall shew you the various apparatus, as also the experiments, and the method of applying the fluid in disease.

It has been long known, that the torpedo*, gymnotus electricus, &c. &c. have the power of giving a sensation to other animals, similar to the shock felt by the discharge of a Leyden jar: by means of this power they procure their food.

* See Mr. Hunter's anatomical description in the Philosophical Transactions.

They have been discovered to arrest their prey at a distance, to benumb them, and instantaneously to inflict death on creatures far surpassing themselves in strength and velocity.—Mr. Welsh first explained the power of the torpedo by the known laws of electricity; he also first obtained a spark from the gymnotus, and discovered that the gymnotus is sensible whether the substances brought near him are proper or not for receiving the discharge.

In the year 1786, Dr. Cotunnio, professor of anatomy at Naples, published the following account in the Journal Encyclopédique de Bologna:—"A medical student felt great pain at the bottom of his leg; he immediately applied his hand to the part, and laid hold of a mouse which had bit him; he began to dissect it; on touching the intercostal or diaphragmatic nerve with his scalpel, he felt a sensation like an electric shock through his left arm, as far as the neck, attended with an internal tremor and a painful sensation in the muscles of his arm, and such a giddiness of the head, that, being frightened, he dropped the mouse: the stupor of the arm lasted upwards of a quarter of an hour." Experiments were made and published on this discovery by Mr. Vassalli, member of the Royal Academy of Turin,

Turin, in the year 1789. I cannot learn what experiments he made, but the result of them was the following theory:—that an accumulation of the electric fluid is retained in some part of the body, that it might be used when occasion required it. I do not hear of any experiment being published after those of Vassalli, of the shock received by Cotunnio's pupil.

In the year 1790, the following extraordinary circumstance took place:—S. Galvani, professor of anatomy at Bologna, was one evening in his laboratory, making electrical experiments, with some friends and his nephew: on the table where the electrical machine was placed some frogs were laid, that had been skinned for the purpose of making broth; one of the company, who was assisting in making the electrical experiments, happened by chance to touch the sciatic nerve of one of the frogs; at this instant the muscles were thrown into strong convulsions. Galvani's wife was present; she was struck with this phenomenon; and observed the convulsions took place every time a spark was drawn from the conductor of the electrical machine. She immediately informed her husband: he thought those contractions might be occasioned by the nerve having been wounded by the scalpel; he pricked

pricked a nerve, but no motion or convulsion ensued; he then touched the nerve with a scalpel as before, and directed a spark to be drawn from the conductor of the electrical machine at the same instant, on which contractions were immediately renewed. On making another trial, the frog remained motionless, which perplexed him at first, but on observing that he held his scalpel by its ivory handle, he took hold of the metal, and the contractions were renewed: on repeating the experiment, he always found that contractions took place when the nerve of the frog was touched with a conducting substance (while a spark was drawn from the electrical machine), but that contractions were not excited when non-conductors were applied.—Professor Galvani made a number of experiments with atmospheric electricity. He raised a conductor on the roof of his house, from which he brought an iron wire into his room; to this wire he attached metallic conductors, and connected them with the nerves of animals; to their legs he fastened wires, which reached the floor; by means of this apparatus he found contractions were often excited both in animals of warm as well as of cold blood; he then suspended some frogs from the iron rails of his garden, by means of metallic hooks fixed into their spine; he

found

found that the muscles of these animals often contracted, as they had done before by the stimulus of the electric fluid: he thought these contractions were produced by atmospheric electricity; however, he continued his experiments, by placing frogs in various situations: a prepared frog being placed on an iron plate, the professor happened to touch the frog with a pair of forceps, and convulsions were immediately produced; by this accident he discovered that he could produce contractions at pleasure. Galvani published an account of his discoveries in the year 1791: he says, if you lay bare the sciatic nerve of a frog, and take off the integuments, then place the nerve on a plate of zinc, and a muscle on a plate of gold, and connect these metals by means of any conducting substance, contractions are produced; but if non-conductors are used to connect the metals, contractions are not excited.—Experiments were made on this discovery by Volta, Valli, Fowler, Hombolt, Monro, Robinson, &c. &c.—Fowler having laid bare, and separated from the surrrounding parts and from each other the crural artery and nerve in the thigh of a full grown frog, he cut out the whole of the nerve between the pelvis and the knee; he then insinuated beneath the artery a thin plate of sealing-wax, spread upon paper, and broad enough

enough to keep a large portion of the artery completely apart from the rest of the thigh : the blood still continued to flow through the whole course of the artery in an undiminished stream : the artery thus partially insulated, was touched with silver and zinc, which were then brought into contact with each other, but no contraction whatever was produced in any muscle of the limb. This experiment was frequently repeated upon different frogs, both in whom the nerve was and in whom it was not divided : the result was uniformly the same; but vivid contractions were produced in the whole limb when an electrical spark, or even a full stream of the aura, was passed into the artery.

Dr. F. made some experiments on worms and leeches, which are supposed in general to be destitute of a nervous system, to ascertain if the Galvanic fluid would produce any effect on muscle alone. He found action could be produced in worms, when rendered sensible by disease or irritation. A curious effect was produced by placing a leech or worm on a piece of silver, and suffering it to touch a piece of zinc with its mouth, which caused it to recoil instantaneously, as if in violent pain. He does not, however, think these experiments sufficiently conclusive,

as it is difficult to determine whether those animals are furnished with nerves or not. He observes, when the bulk of metals is large; and the quantity of surface of an animal with which they are in contact is considerable, the contractions are both stronger and more readily excited than when the reverse of this is the case, for that he almost always was able to make a limb contract by laying it upon a broad plate of zinc and a half-crown piece for the excitors long after a small piece of zinc and a silver probe had failed to produce any effect.

Dr. F. finds that if a nerve is suffered to dry, or if you dry it with fine muslin, contraction cannot be produced; but that on wetting the nerve contractions were renewed. He filled the abdomen of a frog with mercury, and passed a rod of silver through it to the sciatic nerve, a piece of zinc touching both, but contractions were not produced; when water was substituted for mercury, violent contractions took place *.

Dr. Valli concludes, from a variety of experiments, that the nerves possess at every part a vital principle, which perishes in proportion to

* See Fowler's Experiments and Observations relative to the Influence lately discovered by M. Galvani, and commonly called Animal Electricity.—Printed for Johnson, 1793.

the repetition and intensity of the shock; this principle gradually perishes of itself, and it is also from the highest part that it first begins to disappear. Valli found that tying the nerves sometimes prevented action, but at other times it did not, but he found that when the ligature on the nerve included the muscle, action did not take place, and that on strecthing the nerve a little, so that the ligature was at a small distance from the muscles, movement took place*.

Dr. Monro demonstrated to his class at Edinburgh the possibility of exciting contractions in the limb of a frog without either of the metals he employed being in contact with it, or having any other communication with it than through the medium of some moist substance.

Gren, in his Introduction to Nat. Philosophy, 1797, says, contractions are produced by a solution of an alkali and diluted nitric acid; or if water is placed in one glass and vinegar in the other, and a circle is formed through the frog from a nerve to a muscle, the communication being made by a single metal.

Dr. Wells finds that one metal and charcoal excite the contraction of animals as readily as two

* See Valli's Experiments on Animal Electricity, 1793. —Johnson.

two metals, and that contractions could be excited by one metal only, when it has been rubbed upon another metal or upon the hand. Charcoal may, by the same means, be made to produce the same effect: he proved, by a variety of experiments, that the friction does not in these cases communicate electricity to the metal or charcoal.

Volta found, that if you lay a gold plate on the apex of your tongue, and place a plate of zinc between the upper lip and gum, and bring the metals into contact, you will experience a peculiar taste: this fact was known to Sulzer, and published in his *Théorie général du Plaisir*, forty years ago:—he says, if you take two pieces of metal, lead and silver, and make them meet on the tongue, you will experience a taste somewhat like green vitriol; but if they are not brought into contact, no such taste is perceived. Dr. Fowler observed, that the instant the metals were bronght into contact, the nerves of vision were stimulated as a flash of light was perceived.

Professor Robison found that irritation might be increased, by employing several pieces of silver and zinc.

In a letter to Dr. F. published in Fowler's Experiments, he says, "I had a number of pieces of zinc made of the size of a shilling, and made them up into a rouleau with as many shillings;

I find that this alternation, in some circumstances, increases considerably the irritation, and expect on some such principle to produce a still greater increase. If the side of the rouleau be applied to the tongue, so that all the pieces are touched by it, the irritation is very strong and disagreeable. This explains what I have often observed, the strong taste of soldered seams of metal. I can now perceive seams in brass and copper vessels by the tongue, which the eye cannot discover, and can distinguish the base mixtures which abound in gold and siver trinkets.

Volta observed, that a small quantity of alloy will communicate Galvanic energy to a metal; he found that if a cup made of tin or zinc be filled with water and placed upon a silver waiter, and the point of the tongue is applied to the water, it is found insipid; but when you lay hold of the silver waiter with your hand, well moistened, and apply your tongue as before, you perceive a strong acid taste. It has long been observed, that porter has a different taste when drank from a silver or glass vessel, than when drank from a pewter vessel. Robison says, the flavour of a pinch of snuff taken from a box made of tin plate, coated with tin foil, is very different when part of the coating is worn away, from what it is where the coating is intire.

In

In the year 1800, Signor Volta discovered that if a number of plates of copper and silver, and pieces of cloth soaked in pure water or in salt and water, are piled one on another, first a plate of copper, then a plate of silver, then a wet cloth; then a plate of copper, then silver, and so on till a pile is formed of twenty or thirty metallic pairs, with wet cloths between them, a shock can be given (pl. III. fig. 6.). If a person wet his hands in a mixture of salt and water, and touch the top of this pile with one hand, and the bottom of the pile with the other, he will receive the shock.

Volta constructed a battery of twenty or thirty glasses filled with water. In the first glass (*a*, pl. III.) he placed a plate of zinc; in the second glass (*b*,) plates of silver and zinc, but so as not to touch, and so on to the last glass, in which was only a plate of silver (*b*,). A metallic conductor (*c*,) connected the zinc in the first glass to the silver in the second, and so on to the last glass. He found if you made a communication from the zinc in the first glass to the silver in the last glass by means of metallic rods, or with your hands, you received a shock.

Mr. Davy discovered that a battery may be formed with one metal, if proper fluids are applied

plied to their surfaces. He also constructed a battery of pieces of charcoal and different fluids. The first glass contained water, the second nitrous acid; these are connected by wet cloths. He then connected the second containing the acid, with the third containing water, by means of charcoal, and so on for twenty or thirty pairs of glasses, the communication being formed from the water in the first glass to the acid in the last, a slight shock is perceived.

M. La Grave, member of the Galvanic Society at Paris, formed a pile of brain muscle and layers of hat; he made many experiments before he succeeded: he formed first a layer of muscle, then a layer of brain, then a layer of hat, moistened with salt and water, this he tied to the insulated rods at the sides of the pile; when he had formed sixty pairs of muscle and brain, he says its effect was decisive.

Mr. Cruikshank constructed a trough of baked wood, containing pairs of metallic plates, the interstices formed by the pairs of plates he filled with the usual solutions. You will find these troughs much more convenient for your experiments than the pile. (See pl. III. fig. 7.)

Mr. Carlisle discovered that the Galvanic shock decomposed water.

Mr.

Mr. Nicholson finds the Galvanic fluid is sensible to the electrometer; that the silver end of the pile was in a minus state; the zinc end, plus. Mr. N. caused the copper wire from the silver end to terminate in a tube of water, as also one from the zinc end, the wires being at a small distance: he observed gas was produced from the silver end of the pile, which was found to be hydrogen, and that the wire connected with the zinc end became oxidated. He now used a wire of platina, and found gas proceeded from both ends; that from the silver end was hydrogen, that from the zinc oxigen. The gasses were generated nearly in the proportion requisite to produce water.

Mr. Henry, by means of the Galvanic apparatus, decomposed sulphuric and nitric acid, and the water of muriatic acid. When oximuriatic acid was tried, the water was decompounded, and the acid was deoxigenated.

Col. Haldane observed, that on immersing the pile in water the action was suspended, and that the pile acted more powerfully when immersed in oxigen gas, but that its action was entirely suspended in azote, or in a vacuum.

Mr. Davy found that when pure water is used to moisten the cloths, the pile will not act, and thinks the energy of the pile is in proportion

to

to the rapidity with which the zinc becomes oxidated.

Professor Tromsdorff burnt gold-leaf and other metals with a pile of zinc and copper: Fourcroy made a pile of six large plates of zinc and six of silver, and found that though this pile readily burnt wire, it gave very slight shocks, and that the same surface of metals made into small plates afforded a stronger shock, but would not burn metals so readily.

Mr. Cruikshank observed, that when the wire of his trough terminated at the surface of the water, the silver end emitted from the water a brush of fire; the zinc end produced only a dense spark.

Dr. Wollaston made an experiment by coating two silver wires to within a small distance of their ends; the wires were connected with the positive and negative conductors of an electrical machine; the spark was taken from one to the other through a solution of copper; the end of the wire, connected with the negative conductor, was covered with reduced copper; no change was produced in the other. The negative thus corresponding with the silver end of the pile, Dr. W. placed wires to the positive and negative conductors, and connected them with paper, stained

stained with blue juices; that from the negative turned the paper green, that from the positive red: he now placed the wires from the zinc and silver end of the pile on blue paper; the paper at the zinc end was turned red, that of the silver green.

Dr. Van Marum charged both the single jars and the large batteries in the Teylerian Museum at Haerlem, by means of the Galvanic pile; in all cases they were charged to the same degree of intensity with that which the pile itself indicated to an electrometer: when the zinc was at the top of the pile, and communicated with the inside of the jar, the electricity of the inside was found to be positive, and when the pile was reversed it was negative. It was found that the shocks given by the battery charged from the electrical machine, were not perceptibly different from those given by the battery when charged to an equal intensity by the pile.

Gentlemen, you know that by agitating the blood by means of a whisk or rod, we can produce fibres. M. Circaud, of Paris, found on submitting fibres thus produced to the action of the pile, contractions were produced, succeeded by relaxation; and on again forming a circuit, contractions were renewed.—Mr. Delametherie found that when any portion of coagulated blood adhered to the fibres, and was touched by the

wire from the top or zinc end of the pile, its colour was changed from dark to a pale red; the change of colour was only produced from the zinc end of the pile, and when the wire from this end was plunged into the lower part of the fibres, and the wire from the copper end was applied to the other end, this being covered with blood, a change of colour did not take place.

When the fibres were cooled to the temperature of the atmosphere, they had nearly lost their power of contracting, but recovered their irritability by being sprinkled with warm blood.

M. Bouvyes des Mortiere says, he applied the Galvanic fluid to a urinary calculus, and that it dissolved it. A round hard piece of calculus, weighing one grain, was totally dissolved in twenty-four hours; during the same space, a fragment of a hard calculus, weighing five grains, lost about a fifth of its weight.

Professor Aldini was the first who tried the effects of the pile on the dead human subject*. His first experiment was on a person decapitated at Bologna; the next was on the body of Forster, who was executed at Newgate, for murder, last January. The Galvanic stimulus produced contractions in various parts of the body, though it had

* Experiments were made on amputated limbs with the simple Galvanic circle, some years ago.

had been exposed an hour in the temperature of two degrees below the freezing point of Fahrenheit's thermometer.

The conductors being applied to both ears, which were moistened with salt and water, a motion of the head was produced.

Conductors applied to the ear and rectum, excited very strong contractions.

When conductors were applied to the sciatic nerve, and to the spinal marrow, contractions were not produced.

Very little action was produced when the conductors were applied from the sciatic nerve to the peronæal nerve.

Contractions were produced seven hours after death.

The apparatus had now nearly lost its power of acting, or convulsions might have been produced for a greater length of time.

I shall not give the experiments made on Forster, as a work will be published in a few days, by Sig. Aldini, which, I am informed, contains them and a variety of other curious experiments.

It is not certain in Forster's case whether the heart did or did not act. Mr. Hutchins having opened the thorax and pericardium, Mr. Cuthbertson and myself immediately, by the desire of

Sig. Aldini, applied the conductors to the heart, Mr. C. to the right ventricle, and I to the left. I exclaimed, "the heart acts;" one of the gentlemen present thought it did. Sig. Aldini, Mr. Keate, Dr. Pearson, Mr. Cuthbertson, and the other gentlemen, were of opinion it did not. I applied the conductor again and again, and certainly action was not now produced. Possibly what Sig. Aldini, and the gentlemen present, said, is true, that I moved the heart by the conductor, and that it was not the effect of the fluid. I should not have mentioned this trifling circumstance, had it not been asserted that the heart is not susceptible of the Galvanic influence. In several snbsequent experiments, I have observed, that the hearts of animals contract like other muscular parts, when subjected to the Galvanic influence: (Dr. Pearson has observed this in several experiments). Messrs. Vessailli and Rossi, members of the Galvanic Committee of the Academy of Sciences at Turin, prove this fact by the following report: Their experiments were made on a man, decapitated September the 8th:—A rod from the pile formed a communication with the spinal marrow, intercostal nerve, and the par vagum: the different regions of the breast were moistened with some solution; a rod from this was connected to the other end of the pile, when

strong

strong tetanic shocks were obtained through the body, and such violent palpitations of the heart, that on the hand being applied to the region of the fifth and sixth ribs, it was strongly struck by them; inspirations and expirations were produced, accompanied with a hissing noise. After opening the thorax, the palpitations of the heart continued; when they ceased, by establishing a communication between the heart and pile, and from the great intercostal nerve and par vagum, they were renewed. They say that the heart generalty ceases to act in about forty minutes after death.

Mr. Nyster says, in a great number of trials, that, of all the organs, the heart was the longest sensible to the Galvanic stimulus *. The heart of a man who had been decapitated, continued excitable four hours and a half after death, and that of a frog fifteen hours.

Messrs. Vessailli, &c. found that on coating the aorta, and making a communication with one end of the pile, and bringing a conductor from the other end to the cæliac plexus, that contractions were produced in the Aorta. The last costal

* I have not found this to be the case; indeed I have uniformly observed, that the heart was the first part which lost its power of contracting.

costal nerves were coated and connected with the pile; a conductor was brought from the other end of the pile to the Thoracic duct, when contractions were produced.

One of the eyes being taken out of the orbit was laid on a plate of glass, coated in the middle with a plate of lead; the trunk of the optic nerve, and the nerves from the lenticular ganglion, were in contact with this coating; a communication was formed between the lead and one extremity of the pile; a conductor was passed between the sclerotic coat and the cornea, and connected with the other end of the pile, when the pupil instantly contracted. The Galvanic Committee of Sciences at Turin, found that the different species of sensitive plants, such as the Mimosa pudica, the Mimosa sensitiva, the Mimosa asperata, and the Cassia sensitiva, are sensible to the influence of the Galvanic pile.

The most curious discovery is that of Professor Aldini; it is as follows: if you prepare a frog by skinning it, and bring the great sciatic nerve in contact with a muscle, contractions will be produced, (the parts brought into contact being moistened with salt and water.)

Professor Aldini also observed, that you can produce contractions in an animal of cold blood, if its nerve is applied to a hot-blooded animal;

for

for example: the person who makes the experiment must be insulated; his hands well moistened with salt and water: he must apply one of his hands to the muscle of an animal recently killed, and with the other hand apply the nerve of a frog to the spinal marrow of the hot-blooded animal, which must be also moistened with the salt and water, when contractions will be produced in the cold-blooded animal.

If you moisten your hands with salt and water, apply one hand to a muscle, and with the other suspend a frog by his legs, leaving the sciatic nerves hanging down; and then bring the nerves near the muscles of the warm-blooded animal, the nerves will be attracted.

Gentlemen, before I begin the experiments, it will be necessary to explain the Galvanic apparatus.

Volta's Pile:

Plate III. fig. 1. *q*, is a pile of small plates; fig. 6. *w*, is a pile of large plates; *q*, is a table on which the pile is placed; *r*, a piece of metal laid on the table, connected with the bottom of the pile, for the convenience of attaching the conductor, *u*; *p*, is a plate of copper, sol-

dered

dered to a plate of zinc, *s*; *t*, is an interstice between the first and second pair of plates, which is filled with cloth, moistened with a solution of sal ammoniac or diluted nitrous acid; *r*, is the third pair of plates, an interstice being seen between this and the second pair. Thus you observe, in building the pile, you place on the table a pair of plates, the copper side of the plate is applied to the table, on the zinc side the wet cloth, then the copper side, the zinc being at top, and so on till the pile is completed. Thus we have copper at the bottom of the pile, and zinc at the top.

Mr. Cruikshank's Trough.

Plate III. fig. 5 and 7. The trough is made of baked wood; grooves are made opposite to each other the tenth of an inch in depth, and sufficiently wide to admit a plate of zinc, *a*, and one of copper, *b*, soldered together. Three grooves are made in the space of an inch, an interstice being left between each pair of plates, which is represented by the white parts, as seen in the plate, which are to be filled with a solution of sal ammoniac or diluted nitrous acid. The soldered plates are placed into the grooves,

and

and cemented by a composition of gum-lac and turpentine, so as to be made water-tight.

Volta's Battery of Glasses.

Plate III. fig. 9. In the first glass is a plate of zinc, *a*; in the second glass is a plate of silver, *b*, connected by a metallic conductor, *c*; this alternation of silver and zinc is continued (being connected by conductors), to the last glass, in which there is only a plate of silver, *b*.

Apparatus for obtaining the Gasses from the Decomposition of Water separate, as constructed by Mr. Cuthbertson.

Plate III. Fig. 8, is a glass vessel, perforated at *l*, *n*, through which pass two wires which are received into inverted tubes, *o*, *m*, which are placed on a plate of glass that rests on cement that is fastened to the sides of the vessel, in which there are two apertures to allow the water in the the glass to communicate freely with that in the tubes.

Cuthbertson's Condenser, and Condensing Electrometer.

Plate III. fig. 4 and 3.—*a*, fig. 4. is a glass cylinder; *b*, is a brass stand, on which the cylinder is fixed by means of cement; *c, c*, are two pieces of tin foil connected with the bottom, and glued to the side of the cylinder; *d*, is the top of the cylinder, to which is attached *g*, one of the brass plates of the condenser, a side view, seen at *g*, fig. 3.; *h*, fig. 3. is the uninsulated plate of the condenser, connected to a brass rod, *i*, and fastened by means of a hinge, *k*, to the bottom of the electrometer; *e*, fig. 4. is a pair of forceps, connected with *d*, the top of the electrometer; *f*, are two slips of gold leaf held by these forceps.

Explanation of the Action of this Electrometer, independent of *g, h*, the Condensers.

Expt. 1. I excite this sealing-wax by rubbing it; I draw it on the brass head of the cylinder, *d*; you see the gold leaves diverge; they diverge to obtain electricity from the surrounding bodies, they having been robbed of a part of their natural quantity of electricity by the excited sealing-

sealing-wax. If I apply the excited sealing-wax again, they diverge more, having lost a still greater portion of the electric fluid, and continue diverging to acquire electricity to restore the equilibrium.

Expt. 2. I electrify the gold leaves negatively again, and they diverge; I excite this glass rod by rubbing it; I hold it near the head of the machine, and the gold leaves unite on receiving the superabundant electricity from the rod.

Expt. 3. I excite this glass rod by rubbing it; I apply it to the top of the electrometer, and the gold leaves in the electrometer diverge, they having more electricity than their natural quantity, diverge to give it to the surrounding bodies. I excite the rod again positively, and apply it as before, and they diverge still more for the same purpose. I now excite this sealing-wax, which you know is negatively electrified; I apply it near the head of the cylinder, and the gold leaf closes, in the act of giving off its electricity to the excited sealing-wax.

Use of the Condensers.

You recollect, Gentlemen, that electrics can be charged. Air is an electric. I confine a plate of air between the condensers, seen at *g*, fig. 4. and *g*, *h*, fig. 3.: the plate of the condenser, *g*, fig. 3. is insulated by means of the glass cylinder; the brass plate of the condenser, *h*, is connected to the ground by means of *i*, *k*, &c. I now collect a quantity of electricity on a glass rod, by exciting it, and by drawing it on the insulated plate of the condenser, *g*. I charge the plate of air which is between the plates *g*, *h*; if it is strongly charged, it will be sensible to the gold leaf in the electrometer, inasmuch as it is connected with it by the brass head of the machine. Now by separating the outside plate by means of the rod, *i*, the charged air is liberated, and the superabundant quantity of electricity will be received by the nearest conductor, which is the brass head of the cylinder; from thence to the forceps, *e*, fig. 4. so to the gold leaf, which will diverge to give it off to the surrounding bodies.

The large condensing plates, *l*, fig. 4. are made on the same principle as the small ones, and are to increase its power.

This instrument is the most sensible electroscope yet discovered.

Descrip-

Description of Mr. Cuthbertson's self-acting Galvanic Apparatus.

Plate III. fig. 1.—*p*, is a Volta's pile; *b*, a plate of zinc; *c*, a plate of copper; *d*, a piece of wet cloth; *q*, insulating rods supporting the pile; *e*, is a metallic cup containing water, and the copper end of the pile; *f*, *f*, is a conducting rod, insulated at *g*; *h*, is a wheel formed of glass rods, and turned by means of clock-work contained in the box, *i*; *k*, is an insulated cup, containing salt and water; the rod, *f*, *f*, is moved by means of the wheel, *h*, which, every second, connects the copper end of the pile to the cup, *k*. The person that is to be galvanised applies his hand to the water in the cup, *k*, at the same time holding the insulated part of the rod, *l*, in his other hand: he holds one extremity of the rod, *m*, to the part that is to be electrified, this being well moistened with salt and water; the other end of the rod, *n*, is connected to the upper or zinc end of the pile, *b*; thus a circle is formed from the upper or zinc end of the pile, *b*, by the conductor, *n*, *l*, *m*, to the face; from this to the cup, *k*, by means of the left hand; then by the rod, *f*,*f*, to *e*, the cup, connected to the copper end of the pile; now by the action of the rod, *f*,*f*, a shock is received every second. When it is requisite to give

give strong shocks, you must employ a greater number of plates; when this is not required, the blocks of wood, *o, o, o,* are placed on the top of the pile, and screwed down by means of the screw, *p*; *r*, is a key to wind up the clock-work; *s*, is an instrument to scrape off the oxyde which forms on the plates.

I shall now, Gentlemen, make the various experiments in Galvanism.

Expt. 1. Volta's experiment with two insulated metallic plates *, one of copper, the other of zinc (see pl. III. fig. 2.): you observe they are well polished: I apply the upper plate, which is zinc, to the under plate, which is copper, holding them by the glass handles, then touch the insulated plate of the condenser with the zinc plate: I repeat this twelve times; I now turn the uninsulated plate of the condenser † from the insulated one, taking particular care not to touch the insulated plate which is in contact with the small insulated plate, *g*, fig. 4. I turn back the insulated plate of the small condenser, *h*, fig. 3, by means

* Volta calls those substances which bring the Galvanic influence into action, Electromotors.

† See Description of the Condenser.

means of the rod, *i*, and you observe the gold leaves, *f*, in the electrometer diverge. I now excite this sealing-wax, and hold it near the top of the electrometer, and you observe the gold leaves unite; this is a proof that the electricity was positive, for if you reverse the experiment, and apply the copper plate to the condenser, as in the former case, the gold leaves will diverge, but it will be with negative electricity, as is proved by approaching them with excited sealing-wax, when they will diverge more.

The Method of giving a Shock by the Trough.

Plate III. fig. 7. Connect the conductor, *d*, with the copper end of the trough, *b*; hold the conductor by its insulated part, *e*, and apply it to the part which is to be electrified, which is to be moistened with salt and water; connect the conductor, *f*, to the zinc end of the trough, *a*; hold the conductor where it is insulated, and form the circuit. If the conductors are kept in contact with the parts, a tingling sensation is experienced, with great heat. If a shock is to be given, one of the conductors must be continually moved to and from one of the metals at the end of the trough; as this is found to be

very

very troublesome, Mr. Cuthbertson's self-acting apparatus is used in this case (pl. III. fig. 1.), which answers the purpose exceedingly well. When it is required that the shock should be poignant, that part of the cuticle must be removed on which you apply the conductor. By means of this shock, action can be produced in any of the muscles.

Method of producing Contraction in dead Animals.

If on the head of an ox.—The tongue being drawn out, and fixed to the table by means of a scalpel, and well moistened with salt and water, and a conductor brought from it to one end of a powerful trough, while another conductor is passed from the other end of the trough to the spinal marrow, the tongue will be drawn in with great violence.

Method of producing Contractions in the Limb of a Frog, by the mere Contact of two Metals.

Take the limb of a prepared frog (pl. III. fig. 10.); lay the crural nerve, *y*, on a plate of zinc, *z*; let a muscle lay on the plate of gold (&); by

by connecting the metals by the conductor, *a*, strong convulsions will be produced.

Method of decomposing Water.

Plate III. fig. 5. Connect the conductor, *f*, with the zinc end of the trough, *a*; the other end of the conductor must be connected with the wire, *h*, contained in the tube, *g*, *k*, which contains water; the conductor, *d*, is connected with the copper end of the trough, *b*; the end of this is connected with the water in the metallic cup, *h*; from this cup proceeds a wire, *i*, which is received into the inverted tube, *k*, *g*. The circuit being formed, a decomposition of water will now take place: if the zinc end of the pile is connected to a wire that is not easily oxydated, such as gold or platina, the oxygen will be given from this, while hydrogen is given out from the other wire; but if a metal easily oxydated, such as zinc, is used, it will become oxydated from the oxygen evolved while the hydrogen is given out by the other wire.

Method of obtaining the Gasses separate.

Connect one end of the trough to the wire, *l*, fig. 8.; connect the other end to the wire, *n*,

 (observe,

(observe, the water in the vessel is connected with that in the glass tubes): the circuit being formed, the wire from the zinc end will give out oxygen gas (which, according to Mr. Cruikshank, contains a small portion of azote and nitrous acid), while the wire of the copper end gives out the hydrogen, both of which are received in their respective tubes.

Mr. C. found, that the quantity of gas from the zinc end is about one-third of what is disengaged at the copper end, so that the gasses exist in the proportions requisite to produce water.

Mr. Davy finds, if the wires from the piles are brought into separate vessels, connected only by means of moistened cloth, that the wire from the zinc end will produce oxygen, and that from the copper end hydrogen.

Method of reproducing Water.

Let the gasses produced in the tubes be mixed, and pass a spark through them, and water will be reproduced.

Method of charging a Bottle by Galvanism.

Hold the brass ball of the Leyden phial to the zinc end of the pile, and the outside coating

to the conductor connected with the other end of the pile, and the inside of the bottle will be charged positively, as will be shewn by the electrometer. If you hold the ball connected with the inside coating of the bottle to the copper end, and the outside coating to the zinc end, the bottle will be charged negatively.

Method of burning Metals.

The pile is to be built as usual (see pl. III. fig. 6.); connect the conductor, *u*, to the metallic plate, *r*, which is attached to the bottom of the pile; hold the conductor at *x*, and bring the wire, *w*, fastened to the end of the conductor, in contact with the top of the pile, when the wire will deflagrate. You may produce the same effect with gold, silver, and other metallic leaves.

If charcoal is applied in the same manner, it will also burn.

Gentlemen,

I have tried Galvanism in two cases of palsy, both hemiphlegia, one a young lady, aged 20, the other a gentleman, aged 25; and though neither of them were cured, they both received

 benefit,

benefit, particularly the gentleman. After being galvanised for twenty minutes, they felt a glowing warmth the remainder of the day. The apparatus I used was a pile of twenty-four pair of plates, of five inches diameter. I generally connected one conductor to the course of a nerve, the part being moistened with salt and water: the other conductor was sometimes held in the hand, and at other times applied to the spine of the patient, also moistened with salt and water, and applied to the upper end of the pile. Spasm was often produced, as is usual in electricity; the pain was sometimes considerable. When I began to apply the fluid to the gentleman, he could not walk without assistance. In two months he could walk, with the aid of a stick, and could walk a hundred yards without any assistance.

In rheumatism I have had several successful cases.

In a case of opacity of the cornea, it certainly was of use.

I have only had an opportunity of trying it in one case of deafness. I applied the fluid in the same way I applied the electrical. This was continued for three months, but without success. I have tried it in three or four cases of gutta serena. I passed shocks in all possible ways.

When

When I passed one from the tongue to the supra orbital nerve, one of the patients always saw a flash of light; in the other cases they did not. However, although I paid great attention to these patients for upwards of three months, none of them received the least benefit.

In the various journals, both English and foreign, we read of a number of successful cases, from which I have made the following extracts:

Dr. Quensel, of Stockholm, in applying Galvanism in medicine, observed, that the parts to which the fluid was applied became much warmer, and that it increased the perspiration considerably. He observed also, that the zinc pole particularly attracted the blood to the parts to which it was applied, and that bleeding at the nose, head-ache, &c. was frequently the consequence of its application.

He mentions some cases of deafness in which he applied Galvanism, but although some benefit was received, still he did not think it so certain in its effects as had been announced.

He found it very efficacious in head-aches arising from rheumatism, giving immmediate relief. Belts have been made with plates of zinc, connected by plated copper wire and co-

vered

vared with leather, which have been worn round the waist, and found very serviceable in rheumatism of the back, &c.

Dr. Grapengeiser applied Galvanism in paralysis of the arms in two cases, with success, but found no good effects whatever in a third case of the same kind in which he had applied it.

He relates a case of amaurosis and weakness of sight in a patient of debauched habits, with whom different modes of treatment had been made use of, with various success. He applied Galvanism to the mouth and nose, and to the region of the frontal nerve. In about eighteen days he was so much better as to suppose he was perfectly cured, but on returning to his debauchery he relapsed into his former state.

He mentions also a case of imperfect amaurosis; the patient could distinguish his fingers, but not colours. On enquiring into the cause, he thought it arose from excess of venery and drinking, on which account, he says, Galvanism was applied; the patient also took cinchona, valerian, and arnica, &c. which so far restored him that he could perceive the difference of colours, if he looked close, and at length he could do his business as before. Also,

A case

A case of a man, who had been afflicted nine years with inflammation of the eyes, after an incautious extirpation of a plica polonica. Some years after he had a dimness of sight, and complete amaurosis of both eyes. It had lasted seven years when he first saw him. Having tried different remedies, particularly mercurials, he determined on Galvanism, which he applied to the cornea; at the same time he ordered powder of camphor, valerian, and arnica; this was continued six weeks, at which time the patient could distinguish large objects, if brought close.

He relates other cases of amaurosis and defect of vision, in which Galvanism produced very beneficial effects.

He mentions a curious case of a boy, who had been deaf from his infancy, who recovered the perfect use of one ear by the application of Galvanism. He applied Galvanism in many other cases of deafness, &c. with various success, but on the whole, the good effects were sufficiently obvious, to point it out as a very valuable application in these diseases.

Though we have reason to believe, that the Galvanic fluid is but a modification of the electric, yet we should not be too hasty in forming a conclusion.

I think we have every reason to suppose, that

Galva-

Galvanism will probably lead to some important discovery in *Physiology*, and that it may be usefully employed in the cure of disease, as also in suspended animation, inasmuch as we are able to vary the mode of electrification in a manner not practicable by the electrical machine, the Galvanic fluid being produced in large quantities, but in a state of low intensity.

I trust, Gentlemen, that when opportunity offers, you will not be wanting in making experiments, for it is by experiment alone we obtain facts.

In these lectures on Electricity and Galvanism, I have endeavoured to be as concise as possible, knowing how fully your time is employed. When you have more leisure, I would have you study *Cavallo's complete Treatise of Electricity*, which is an excellent work on this subject.

Mr. Cuthbertson published a very interesting work in Dutch, in 3 vol. 8vo. intitled, *General Properties of Electricity*, which I am happy to find he is now translating.

THE END.

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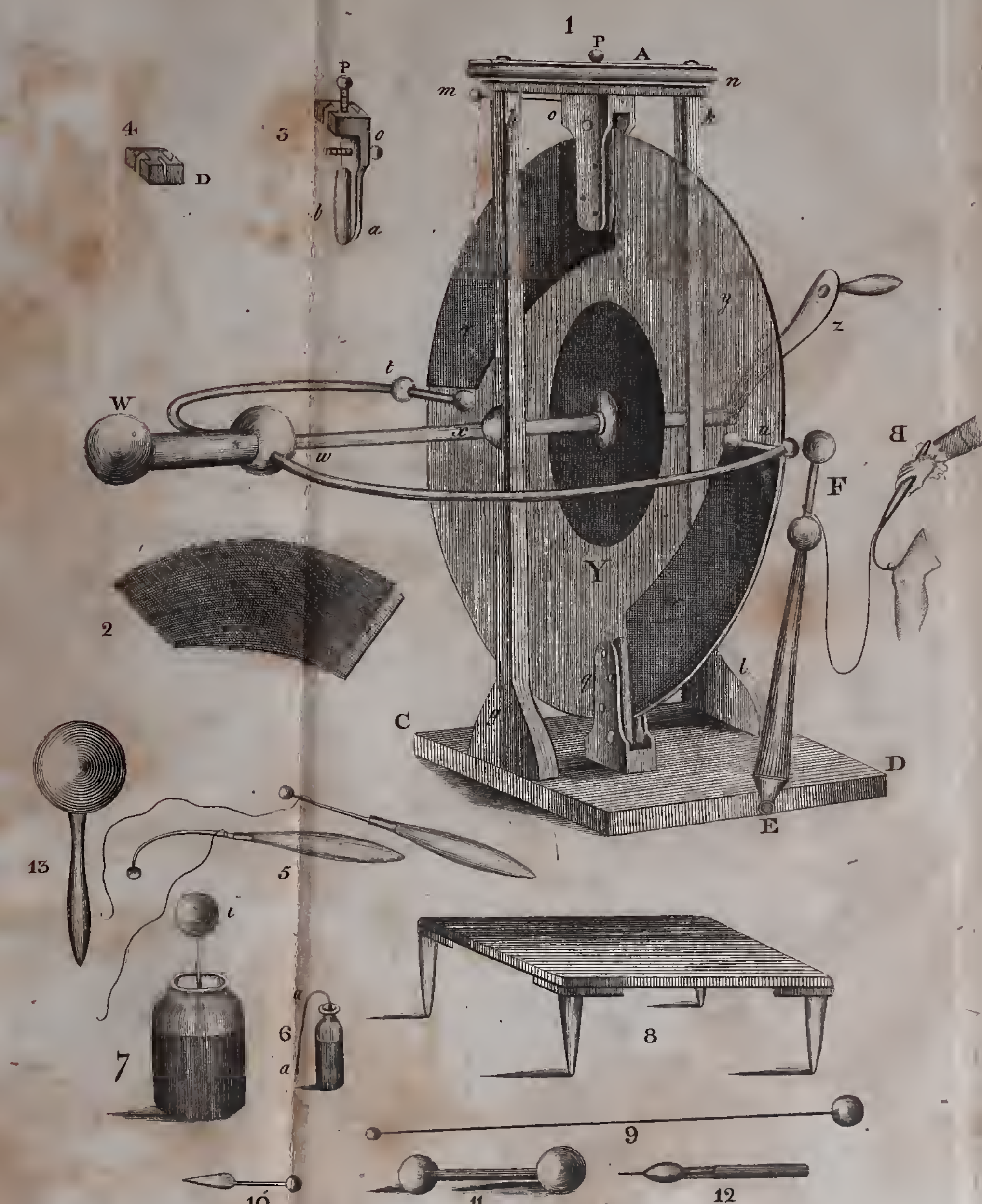

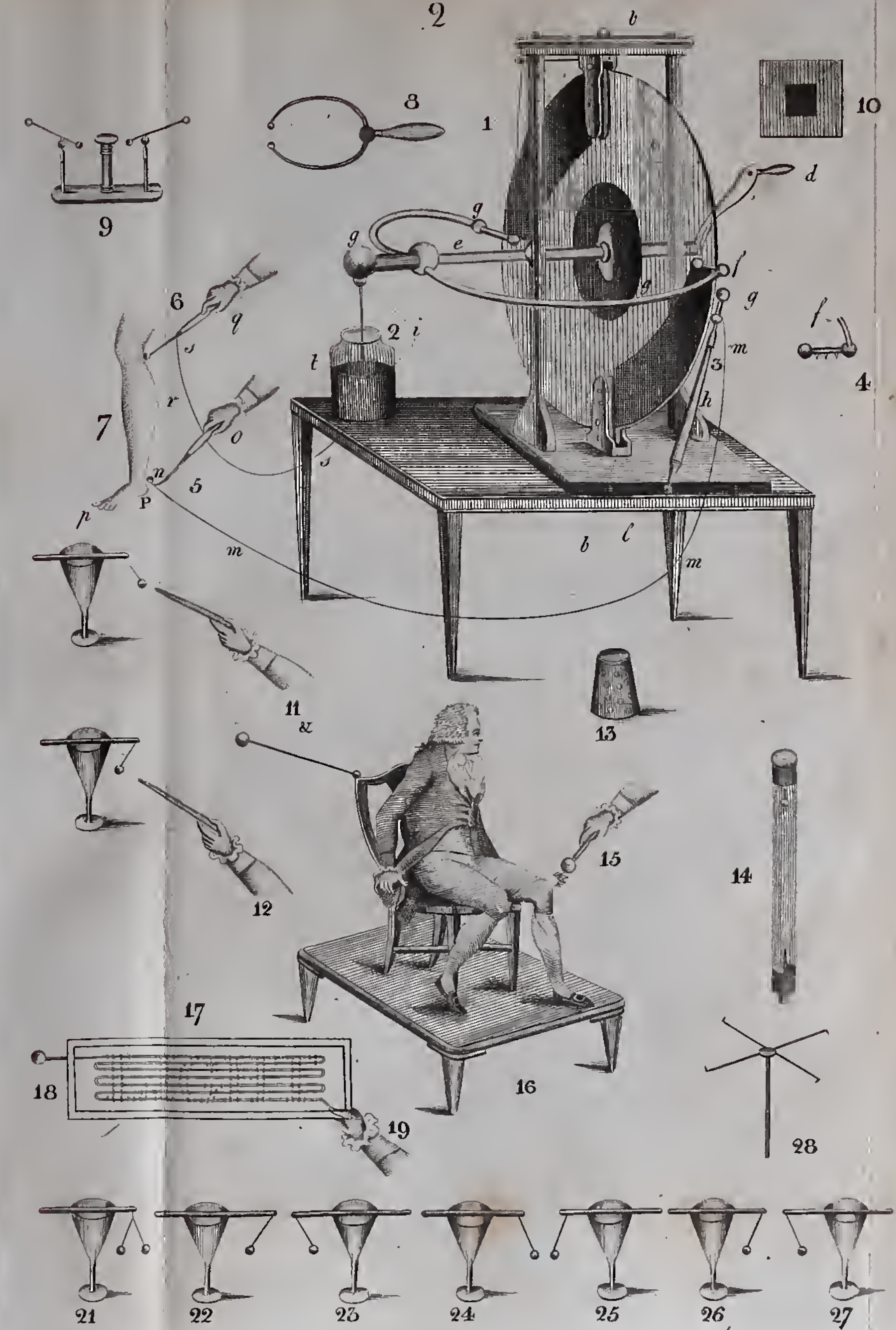
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